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NAVSUP PUB 502  
AFPAM(I) 24-237  
DLAI 4145.14

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# **PACKAGING OF MATERIEL**

# **PRESERVATION**

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DEPARTMENTS OF THE ARMY, THE NAVY, THE AIR FORCE,  
AND THE DEFENSE LOGISTICS AGENCY

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## Chapter 1

# Introduction - Packaging Policy

## GENERAL

AR700-15/NAVSUPINST 4030.28D/AFJMAN 24-206/MCO 4030.33D/DLAD 4145.7 Packaging of Materiel, is a joint regulation for all Department of Defense (DOD) components which establishes policies on the development of uniform requirements for the packaging of materiel acquired, stored, or shipped. The joint regulation implements DOD 4140.1-R, DOD Materiel Management Regulation, and covers policy requirements concerning the following:

- X Packaging
- X Specifications and Standards
- X Levels of Protection
- X Project Information Exchange

It provides uniform criteria for the selection and prescription of packaging at the time of acquisition, storage, or shipment.

While the Packaging of Materiel publication relates to both preservation of the unit packs and packing of the shipping containers, this document will only address preservation requirements, including the levels of protection. Unit packs and intermediate packs will also be discussed in this chapter.

## UNIT PACK

Unit packs are often referred to as interior packs. Figure 1-1 is a diagram which conceptualizes a shipping container with four unit packs and two intermediate packs. Listings of intermediate and shipping containers are found in the MIL-STD-2073-1C, Standard Practice for Military Packaging. This document will be discussed later in the chapters on preservation and preservation methods.

A unit pack is defined as the first tie, wrap, or container applied to a single item, or a quantity thereof, or to a group of items of a single stock number, preserved or unpreserved, that constitutes a single complete or identifiable package.

Unit packs are, for the most part, interior packs; however, there are preservation methods requiring the unit pack to also be the shipping container. Those situations will be presented in chapter four.

## INTERMEDIATE PACK

An intermediate pack is a wrap, box, or bundle that contains two or more unit packs of identical items. Intermediate containers or packs are used when they facilitate handling, storage and reshipment; when the exterior surface of the unit pack is a bag or wrap; when the unit pack volume is less than 64 cubic inches and the exterior container is a rigid type; and when specified by the procuring activity.

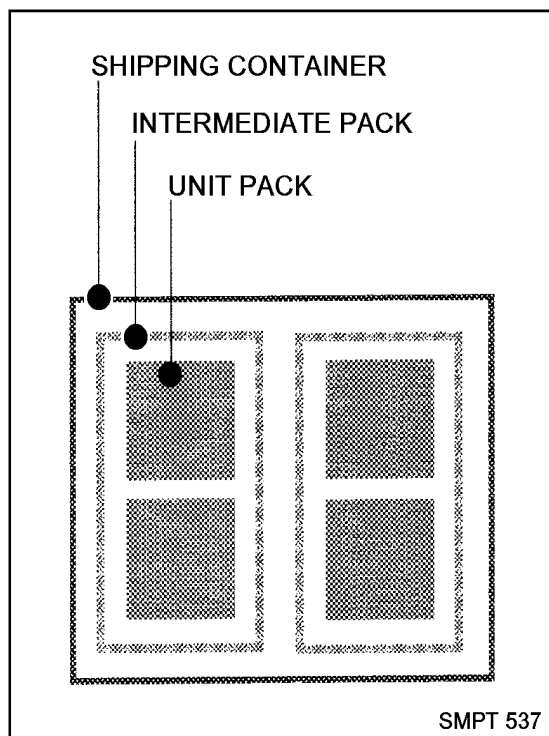


Figure 1-1. A packaging diagram.

The development and ordering of quantities to be placed in the unit, intermediate, and exterior pack require coordination with the managing activity. These quantities will be established after evaluating all known factors, including the following:

- X maintenance concept for the item being supported
- X basis for issue such as allowance and load list
- X life expectancy such as shelf-life and mortality rate
- X chemical and physical characteristics
- X construction and functional requirements
- X fragility or unit cost
- X ease of accountability and inventory
- X commercial practice quantity for like items
- X military standards or applicable regulations

## **EFFICIENT AND ECONOMICAL HANDLING**

The military concept of economy in preservation is to obtain maximum output of adequately protected items at a minimum cost. Economy measures, consistent with the degree of protection required by an item, should be of prime concern to individuals establishing preservation and packaging requirements. They must also be a concern to personnel in charge of or performing packing operations.

Significant savings can be accomplished by reducing the weight and cube; by the employment of options concerning packaging materials, i.e., barriers, wraps and cushioning; and automation. The concepts of "minimum weight and cube packs" and in addition, "a packaging design to fit the item", may not always be possible nor practical. The unit and intermediate packs, shall, however, be of uniform size.

## LEVELS OF PROTECTION

"Levels of protection" is defined as a means of specifying the level of military preservation and the levels of packing that a given item requires to assure that it is not degraded during shipment and storage.

Military level of preservation is the packaging protection given an item during shipment, handling, indeterminate storage, and distribution to consignees worldwide.

The military levels of packing consist of the following:

- X Level A. Protection required to meet the most severe worldwide shipment, handling, and storage conditions. Examples of situations which indicate a need for use of a Level A pack are as follows:
  - o war reserve material
  - o mobilization
  - o strategic and theater deployment
  - o open storage
  - o deck loading

Examples of containers used for Level A packing requirements include, but are not limited to, overseas type wood boxes, and plastic and metal reusable containers.

- X Level B. Protection required to meet moderate worldwide shipment, handling, and storage conditions. Examples of situations which indicate a need for use of a Level B pack are as follows:
  - o security assistance, e.g., Foreign Military Sales (FMS)
  - o containerized overseas shipments

Examples of containers used for Level B packing requirements include, but are not limited to, the following:

- X domestic wood crates
- X weather-resistant fiberboard containers
- X fast-pack containers
- X weather-resistant fiber drums
- X weather-resistant paper and multi-wall shipping sacks

## ELECTROSTATIC DISCHARGE SENSITIVE (ESDS) ITEMS

Packaging required to protect ESDS items against damage and deterioration from the time of acquisition to anticipated use will be provided at the time of acquisition. MIL-STD-1686, Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment, and MIL-HDBK-773, Electrostatic Discharge Protective Packaging, will be used as guidelines in the identification, packaging, handling, and storing of ESDS items.

## PROTECTING RETROGRADE CARGO OR RETURNED MATERIEL

Retrograde materiel will be protected consistent with provisions of the commodity grouping, in the original packaging.

## CONSUMABLE, SERVICEABLE (EXCESS) RETURNS

To prevent deterioration and damage, consumable, serviceable (excess) returns for credit will be returned in the original vendor or depot unit pack or in a unit pack which is the equivalent of the original unit pack. Consider the following before returning these items:



- X Ensure item serviceability and/or if condition warrants return. If not warranted, dispose of locally, as appropriate, through the servicing Defense Reutilization and Marketing Office (DRMO).
- X Failure to follow the above procedures for serviceable returns will result in the loss of credit. To minimize the possibility of credit loss, it is imperative that the item not be removed from the original unit pack until ready for use.

#### **HAZARDOUS MATERIALS RETURN**

When hazardous materials are being returned, packaging must conform to the applicable modal regulations. Modal regulations are found in the following:

- X International Civil Aviation Organization (ICAO) technical instructions,
- X International Air Transport Associations (IATA) regulations,
- X International Maritime Dangerous Goods (IMDG) Code of the International Maritime Organizations (IMO)
- X Title 49 Code of Federal Regulations (49 CFR), and
- X AFJMAN 24-204/TM 38-250/NAVSUP PUB 505/MCO P4030.19/DLAI 4145.3, Preparing Hazardous Materials for Military Air Shipments.

#### **OTHER RETROGRADE CARGO**

Serviceable and unserviceable reparable materiel will be retained in the original packaging to maintain the integrity of the degree of serviceability of the materiel being returned.

Depot level reparables (DLR), serviceable and unserviceable, whose packaging prescription dictates the use of reusable containers, shall be afforded that protection throughout their life cycle.

All items will be identified with the national stock number (NSN), nomenclature, and quantity. Materiel condition tags or labels and markings will be applied as required by MIL-STD-129 and MIL-HDBK-129 and the DOD component. The shipper will be responsible for adequate packaging of materiel returns.

#### **OTHER POLICY REQUIREMENTS**

Other packaging or packaging related policies addressed in the uniform requirement covered by DOD 4140.1-R, previously mentioned, include the areas of commercial packaging, options, military markings, unit pack quantities, safety and health, and ecology.

#### **COMMERCIAL PACKAGING**

Commercial packaging shall be used by DOD components when it is cost effective and when commercial packaging will withstand anticipated logistics conditions. All packaging, including "commercial packaging" shall be based upon the following:

- X nature of the item,
- X known logistics requirements, and
- X economic or normal consumer order quantities.

As previously stated, MIL-STD-2073-1C provides a "military packaging development-decisions chart" which leads to the determination of whether "military packaging" or "commercial packaging" is warranted in accordance with (IAW) ASTM D3951, Practice for Commercial Packaging.

Items not going into stock shall be packaged IAW ASTM D3951. This includes items such as:

- X items intended for immediate use
- X items for not mission-capable supply
- X items intended for depot operational consumption
- X small parcel shipments (CONUS) not-for-stock
- X direct vendor deliveries (CONUS)

Items intended for deliver-at-sea, delivered during wartime, or items requiring reusable containers are exceptions to the above list of items.

#### **OPTIONS**

When standards, specifications, purchase descriptions, packaging data sheets or cards, special packaging instruction, drawings, or other authorized instructions contain options for selecting packaging methods, materials, or procedures, the option that provides protection at the lowest overall cost will be selected.

#### **MARKING**

DOD policy directs components to develop and apply uniform marking requirements to facilitate safe handling and efficient receipt, storage, and shipment of materiel. DOD 4500.32-R, Military Standard Transportation and Movement Procedures (MILSTAMP), provides policies and procedures required to manage and control the movement of materiel through the Defense Transportation System (DTS).

MIL-STD-129, "DOD Standard Practice for Military Marking," is to be used only for marking of military supplies which are intended for storage and shipment within the military distribution system, i.e., for marking of materiel not intended for immediate use, that is stored and/or moved within or between DOD facilities. This document complies with the wording and requirements of MIL-STD-2073-1C.

MIL-HDBK-129, "DOD Handbook Military Marking," is also available to DOD departments and agencies but is used for guidance only. This handbook, although based upon marking procedures from MIL-STD-129, cannot be cited as a requirement. If it is, the contractor does not have to comply.

Hazardous materials shall be packaged and marked in accordance with applicable Federal and international regulations such as the following:

- X Code of Federal Regulations Title 49, Transportation
- X International Civil Aviation Organization (ICAO) Technical Instructions
- X International Air Transport Association (IATA) Dangerous Goods Regulations
- X International Maritime Dangerous goods (IMDG) Code
- X United Nations Orange Source Book
- X Acceptance of Hazardous, Restricted or Perishable Matter, USPS Publication, 52
- X AFJMAN 24-204, Preparing Hazardous Materials for Military Air Shipments

For the purpose of packaging project information exchange, a project is any planned work load involving 160 or more man-hours (including all support functions). This entitles research, development, testing, or evaluation that may result in new or improved packaging concepts, methods, or procedures.

## CHAPTER 2

# Cleaning and Drying

## BASIC CLEANING PRINCIPLES

### IMPORTANCE OF CLEANING

The success of preservation and packing operations depends upon the cleaning of items by suggested processes. A preservative film will not protect an item if the surfaces are dirty or are covered with corrosion-producing particles. Inadequate cleaning makes all succeeding operations ineffective.

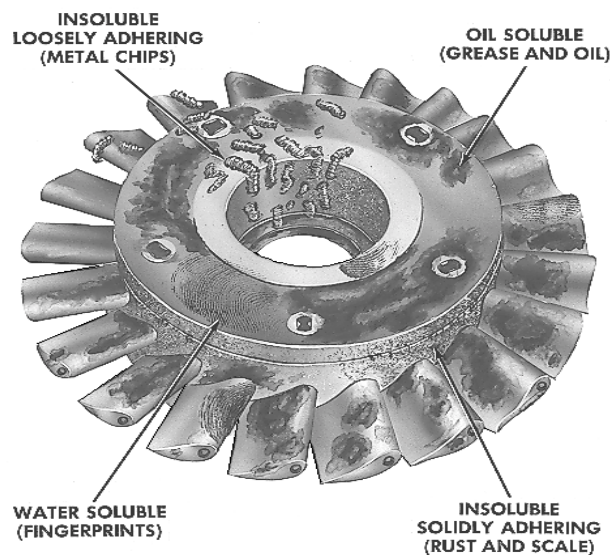
### CONTAMINATION

When surfaces of items are dirty or are covered with substances that are not part of the items, they are contaminated. Every manufactured item is subjected to many kinds of contamination from the time it is produced until it is received by the user. Examples of contaminants are drawing, milling, or cooling compounds, metal shavings, chips, abrasives, shop dirt, or corrosion products that form during various steps in manufacture.

### TYPES OF CONTAMINANTS (FIGURE 2-1)

Contaminants are classified into the following four categories:

- X Water soluble contaminants, such as heat treated salts, welding fluxes, soldering cleansers, chalk, fingerprints, and perspiration, which must be removed with water.
- X Oil (solvent type) soluble contaminants such as oils, greases, soaps, and cutting and drawing compounds which must be removed with solvents other than water.
- X Loosely adhering insoluble contaminants such as solid dirt particles, abrasive grains, metal chips, and filings which can be rinsed off with water or solvent.
- X Solidly (tightly) adhering insoluble contaminants such as mill and heat scale, carbon deposits, rust, and other corrosion products which cannot be removed except by mechanical means.



SMPT 125

Figure 2-1. Types of contaminants.

**EFFECTS OF CONTAMINANTS**

Contaminants affect the surfaces of items in varying ways. Many contaminants are corrosive; others are hygroscopic (they absorb moisture) and promote corrosion. Some contaminants prevent adequate adhesion of an applied coating. Solid contaminants interfere with an applied protective film and provide points of entry for water or other corrosive agents. All of these properties of contaminants tend to cause items to corrode, since corrosion may occur on certain metals whenever any of the following conditions exist:

- X A metal (the item) plus oxygen and water.
- X A metal (the item) plus acids or alkalies and water.
- X A metal (the item) plus salts and water.
- X A metal (the item) plus corrosive gases or vapors and water.

Note that water in any form is the common factor in all four situations.

**REMOVAL OF CONTAMINANTS**

Removal of contaminants depends upon the composition, degree of criticalness, and complexity of the item, and upon the type of contaminant present. Contaminants are not all affected in the same way by a given solvent. For instance, a cleaner that is suitable for removing oil-soluble contaminants may not be capable of removing rust and scale. Likewise, a cleaner that is suitable for removing rust and scale may not remove fingerprints and other water-soluble contaminants. Oil-soluble or easily emulsified contaminants can be removed either by solvents or water-emulsion solutions. Highly finished items contaminated with perspiration, fingerprints, and oil-soluble contaminants require a combination of cleaners to insure the removal of the fingerprints and perspiration. A cleaning process or combination of processes should be chosen that will remove all contaminants.

**CLEANING REQUIREMENTS (figure 2-2)**

Basic cleaning requirements are listed in MIL-STD-2073-1C. Items shall be cleaned and dried by any suitable process or processes which are not injurious to the items. Critical surfaces (close machined tolerances) must be cleaned to ensure total removal of corrosion, soil, grease, fingerprints, perspiration and all other acid and alkali residues. Disassembly must be discouraged. Complex items will not be disassembled without prior authorization and/or technical instructions.

**PROCESS SELECTION CRITERIA**

The selection of a cleaning process depends upon the characteristics of the item, the nature of the contaminants, availability of cleaning materials and equipment, and the safety hazards involved.

**COMPOSITION OF THE ITEM**

The composition of the item limits the choice of the cleaning process. Aluminum or zinc items should not be cleaned in highly alkaline cleaners because of detrimental effect of the cleaner. Nonmetallic items of rubber, fabric, cork, or other organic composition should not be cleaned haphazardly in organic or water-soluble alkaline cleaners. If solvent cleaning is applied to such items, the solvent exposure must be brief and scrubbing action limited when dimensions and use conditions of the item are critical. Petroleum solvents are detrimental to most rubber and synthetic rubber materials. If metallic and nonmetallic materials are combined in an assembly, the cleaning process must be carefully considered and the choice of the process governed by the nature of the materials combined in the assembly.

**SURFACE FINISH OF THE ITEM**

Some cleaning processes are safe to use on highly finished and precision surfaces while other processes are likely to mar the finish. For instance, alkaline cleaning should not be used on polished aluminum. Acid cleaners

are used on iron and steel with extreme care. For most critical surfaces of metal items, the petroleum solvent or vapor degreasing processes usually are recommended. Surfaces of rough forgings or casting, rough ground or rough machined items, or surfaces having no finishing after stamping or drawings are cleaned by alkaline cleaning processes. Items with porous surfaces, small crevices, or with capillary holes are not cleaned with alkaline cleaning processes because the complete removal of all residues is not possible and corrosion will result. This is also true of items which have extended lap joints, riveted areas, spot-welded additions, and similar constructions. Porous, oil-impregnated, or graphite lubricated items should be cleaned by wiping with a dry cloth. Items with porcelain or painted surfaces are not cleaned in strong alkaline solution. Solvent cleaning cannot be applied indiscriminately to painted surfaces; however, zinc-chromated primers, exterior paints, lacquers, and enamels are usually handled safely in petroleum solvent cleaners.

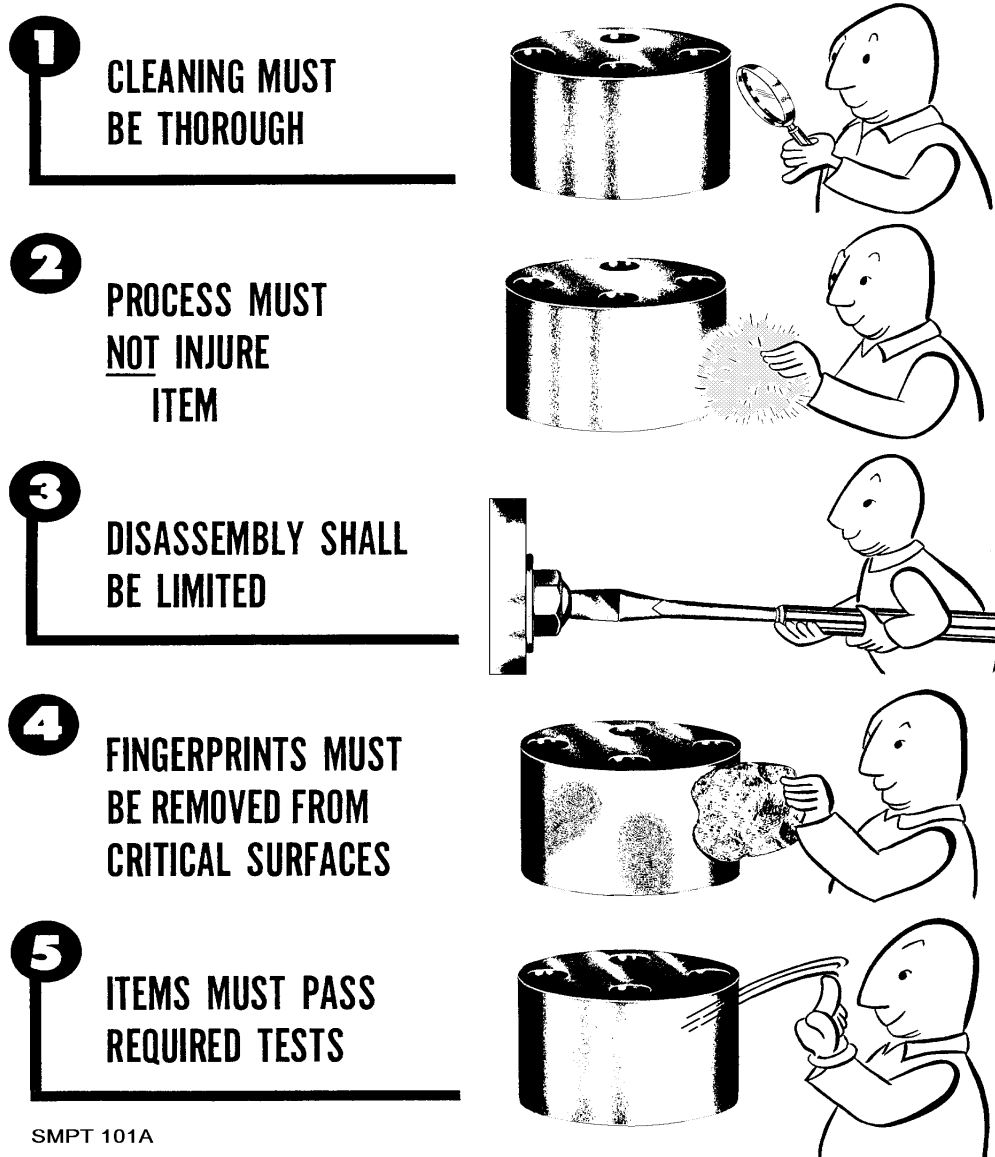


Figure 2-2. Cleaning requirements.

### **COMPLEXITY OF THE ITEM**

Items having irregular surfaces, crevices, undercuts, and pockets that could trap the cleaning fluids may only be cleaned by brushing or wiping when solvent cleaning is employed. Clean complex assemblies prior to assembly. Such assemblies as electric generators, motors, starters, gauges, meters, timing devices, and other complex units should be cleaned before assembly and kept clean thereafter.

### **AVAILABILITY OF FACILITIES**

Approved materials and equipment should be used wherever possible. If the desired cleaning materials and equipment are not available, consider carefully the selection of an alternate process. Solvent cleaning can be done in pails, buckets, drums, or barrels in an emergency. The hot vapor degreasing process requires specially designed equipment, but the solvents used for vapor degreasing can be used cold if due caution is taken to avoid overexposure to the vapors. Most cleaning processes are not too complex, and operations can be modified to meet the needs of the situation.

### **HEALTH AND SAFETY HAZARDS**

All cleaning materials must be selected and used in accordance with applicable Environmental Protection Agency (EPA) regulations, Occupational Safety and Health Standards (OSHA), Code of Federal Regulations (CFR) 29, Section 1910, General Industry and Air Pollution Control statutes, and regulations in force in the geographic and industrial area where the cleaning is performed. Many of the cleaning processes (for example, vapor degreasing, solvent cleaning, and fingerprint removing) involve the use of chemicals that could present a safety hazard. CFR 29, Section 1910.1200, (the "workers-right-to-know" standard) was written to reduce injuries or illnesses caused by personnel working with or exposed to chemicals. Workers need to know the chemical hazards they are exposed to and the safe practices linked with those chemicals used in the work place. CFR 29, Section 1910, requires that a Material Safety Data Sheet (MSDS) be available to workers at all times. A MSDS contains applicable information regarding product identification, hazardous ingredients, physical data, fire and explosion hazard data, reactivity data, health hazard data, spill or leak procedures, and precautions to be taken in handling and storing.

## **CLEANING PROCESSES**

### **ANY GENERAL CLEANING PROCESS (FORMERLY C-1)**

Any process not required by an order or contract may be used. Any process or combination of processes which will accomplish thorough cleaning without damage to the item will be appropriate. If a specific process cannot be cited, then any general cleaning process is in order. All cleaning processes must result in noninjury to items and the satisfactory passing of the quality conformance test as specified in the Preservation Inspection Provisions, of MIL-STD-2073-1C. Cleaning processes are either mechanical or chemical.

### **Mechanical Processes**

The mechanical processes are used to remove solidly or tightly adhering contaminants. These processes use abrasive materials, pressure tools and power tools and often subject the items to severe treatment. Some of the mechanical processes are air-vacuum cleaning, barrel tumbling, impact tool cleaning, and wire brushing.

#### ***Air-vacuum Cleaning***

This process is used to remove dust and lint from items during final assembly operations. The cleaning of electronic components is an example in which air-vacuum cleaning is used.

### ***Barrel Tumbling (figure 2-3)***

This process consists of the cleaning mass, composed of the items to be cleaned, an abrasive or rolling medium, a fluid lubricant (usually water), and a chemical corrosion inhibitor mixed together in a cylinder or barrel. This cleaning mass rolls and tumbles upon itself in the barrel by being carried up the side until it reaches a point where it slides down because of gravity, thus scrubbing and polishing all surfaces to be cleaned.

### ***Impact Tool Cleaning***

These processes are used on noncritical surfaces to remove mill scale, rust, or old paint coatings. They are done by pounding, hammering, or chiseling the surface of the item with manual or pneumatic hammers, chisels, scalers, scrapers, rotary wheels, or vibrators. Wherever these tools are employed, they must be suitably sharp. Dull tools tend to drive scale and corrosion products into the surface of the metal, creating a nucleus for corrosion. Because they prevent effective cleaning, oily and greasy contaminants must be removed before impact tool cleaning.

### ***Wire Brushing***

Wire brushing removes loose scale, corrosion products, old paint, and similar encrustations from metallic surfaces. It will not remove tightly-adhering mill scale, tight oxides, or embedded corrosion products.

### ***Chemical Processes***

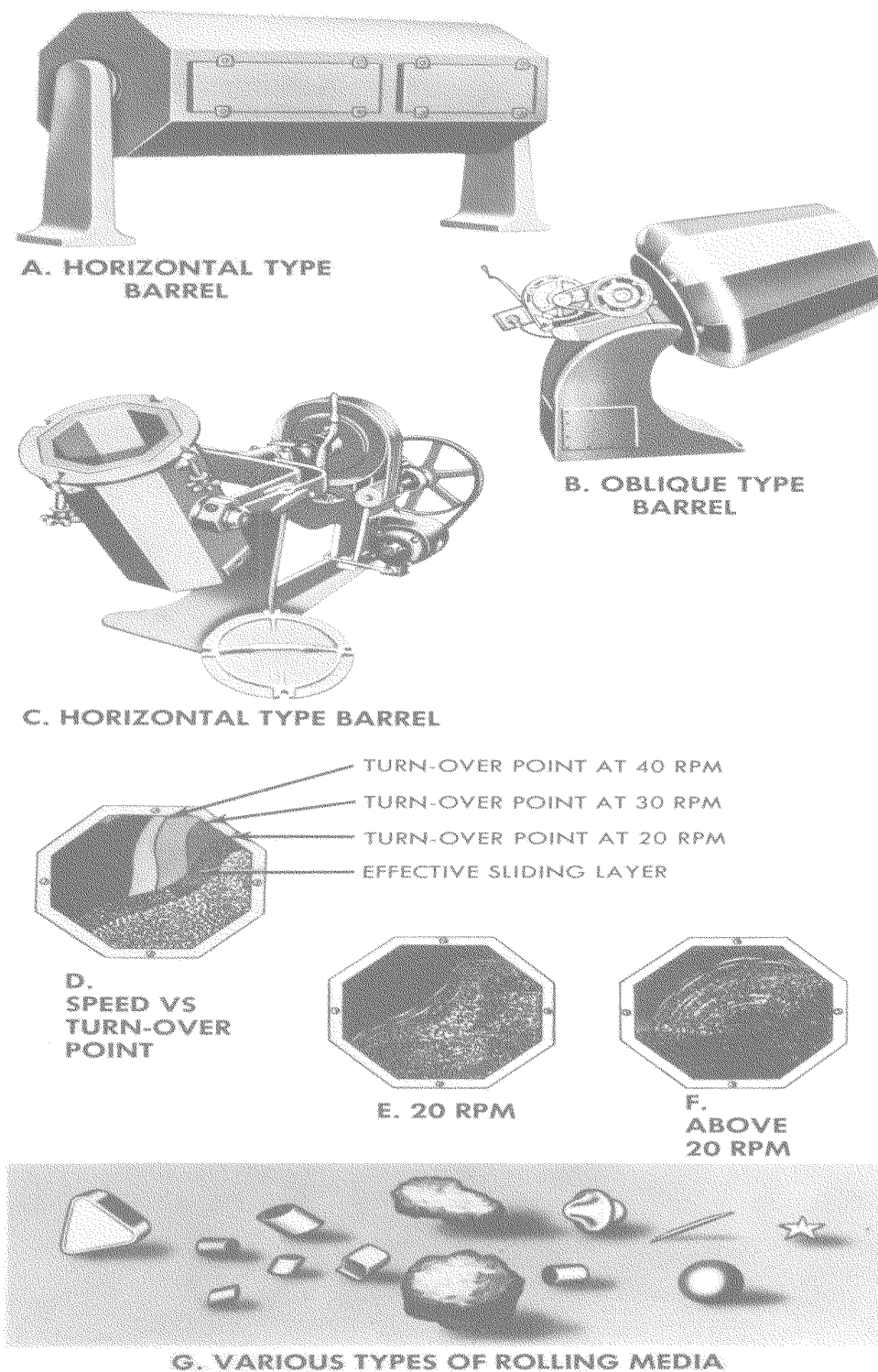
The chemical processes are acid, alkaline, and detergent cleaning.

### ***Acid Cleaning (pickling)***

Acid cleaning or pickling consists of removing surface oxides, scale, and rust from metal by immersion in an acid solution. Oil-soluble contaminants must be removed before acid cleaning. After immersion in the acid solution, the item is rinsed thoroughly to remove any remaining acid from its surface. In some operations, the acid residues are removed by scrubbing, while rinsing or neutralizing the items. In other operations, an alkaline rinse, used to remove the acid residues, is followed by a chromate or phosphoric-chromic acid rinse to neutralize the alkali and retard corrosion. In all cases, the surfaces of the item must be neutral before applying a protective coating. The most common types of pickling solutions are sulfuric and hydrochloric acids. Nitric, phosphoric, and hydrofluoric acids are used for some applications. One of the most serious problems in connection with the acid cleaning is what is known as "acid brittleness" or "hydrogen embrittlement" (Penetration of generated hydrogen on metal surfaces). This may be eliminated by soaking the items in boiling water immediately after pickling, or may be minimized by the use of the proper inhibitor. Water rinsing is a very important operation after pickling to remove all traces of acid and iron salts. If complete removal of such residues by the water rinse alone is doubtful or if the parts must remain unprotected for a period of time, an alkaline rinse is recommended to neutralize any remaining acid residues.

### ***Alkaline Derusting Compounds***

Alkaline derusting, using an immersion process with either electrolytic or nonelectrolytic equipment, removes rust from steel objects better than acid cleaning, and without affecting the dimensions of the base metal in the process. Much less hydrogen embrittlement (entrapped hydrogen bubbles within the porous structure of the metal and rerusting of the base metal) occur when alkaline derusting is used. MIL-C-14460 identifies two types of derusting compounds. Type I is a mixture of sodium hydroxide, sodium gluconate, a complexing agent, and a foaming agent. Type II is a mixture of sodium hydroxide, sodium cyanide, a complexing agent, and a foaming agent.



SMPT 65I

Figure 2-3. Barrel tumbling.



Type I compound is used for rust removal by simple immersion of items in the heated derusting solution. The usual concentration of this compound is 5 pounds per gallon of solution. If type I material is used, the solution is heated to boiling. A "rolling" boil gives effective agitation.

**DANGER**

Type I compound causes severe burns to skin and eyes. Wear goggles or face shield when handling. Avoid dust and fumes. Keep away from food products. In case of eye or skin contact, flush immediately with plentiful amounts of water for at least 15 minutes and get immediate medical attention.

Type II compound is used for the most severe conditions of rusting on exterior or interior surfaces where equipment for electro-cleaning is available. Usually, it is mixed at the rate of 2 or 3 pounds per gallon of solution. This material should not be used at temperatures above 130°F. It should not be used for cleaning portable water tanks, food containers, and similar items.

**DANGER**

Type II compound contains sodium cyanide! Do not mix with or allow to come in contact with acids or acid solutions. Contact with acid liberates poisonous cyanide gas. Keep container closed and in a dry place.

Both type I and type II compounds are used for removing rust and scale from iron and steel. The compounds may be used for cleaning nonferrous metals. However, their effect on the metal to be cleaned should be checked before they are used for cleaning items. These compounds have been found to attack aluminum, copper, brass, and zinc. Articles should be thoroughly rinsed in clean hot water and dried immediately after removal from the corrosion removing compound.

### ***Detergent Cleaning***

Detergent material (MIL-D-16791) is used for removing contaminants from a vast range of items such as rubber, plastics, canvas, and metallic materials. For most cleaning operations, 1/4 to 1/2 ounce of detergent in a gallon of fresh water or sea water, preferably hot, is sufficient. The detergent will efficiently remove grease, oil, and dirt from a wide variety of surfaces.

### **SOLVENT CLEANING PROCESSES**

Solvent cleaning makes use of several solvents, utilizing processes known as solvent cleaning and fingerprint removal. A combination of solvent cleaning followed by fingerprint removal will be discussed extensively in a later paragraph entitled "Perspiration and Fingerprint Removal."

### **Applicability of the Processes**

The solvent cleaning processes are used to remove oils and greases remaining after machining, milling, polishing, and similar operations or any time the item is contaminated with oil-soluble contaminants. Solvent cleaning with pressure spray equipment removes loose chips and other loosely adhering particles produced during fabrication of the item. Solvent cleaning is used when the only contaminant is a light grease or oil. The spraying process is

used on items of simple construction with surfaces that can be reached by the solvent spray. Solvent cleaning will not remove rust or corrosion products.

### **Materials for Solvent Cleaning**

Solvent cleaning materials are dry-cleaning solvent, paint thinner, corrosion preventive fingerprint remover compound, and tetrachloroethylene.

#### ***Dry-cleaning Solvent (P-D-680)***

This is a clear, solvent-based liquid which is neutral to metals and only slightly irritating to the skin. It may be mildly nauseating when excessive vapors are breathed. It evaporates quickly without leaving a corrosion inducing film on metal surfaces. It is used especially for removing oils and greases from metal surfaces by brushing, wiping, spraying, or immersion. Dry-cleaning solvent has a flash-point (the point at which there are sufficient vapors from the solvent to ignite in the presence of a flame or spark) of 100°F., or higher. The material must be used only at room temperature, since heating significantly increases the fire hazard. See the paragraph in this chapter entitled "Environmentally Safe Solvents."

#### **WARNING**

Keep solvent away from any open flame or source of sparks.

#### ***Volatile Mineral Spirits, Paint Thinner (A-A-2904)***

Paint thinner is supplied as two grades of petroleum distillate. Only grade I (light thinner) is used for petroleum solvent cleaning. It is an excellent solvent for oils and greases. It is similar to dry cleaning solvent (P-D-680), having the same flashpoint and degree of toxicity, but is more highly refined and is usually higher priced.

#### ***Fingerprint Remover Corrosion Preventive Compound (MIL-C-15074)***

This is a homogeneous stable mixture of solvent, soap, and water. It is capable of removing water soluble contaminants such as fingerprints, suppressing perspiration corrosion, and temporarily protecting steel surfaces. It is nontoxic and free from disagreeable or offensive odors.

#### ***Technical Tetrachloroethylene (perchloroethylene) (ASTM D 4081, ASTM D 4376)***

Tetrachloroethylene is similar to trichloroethylene. Its differences make it the preferred solvent in some situations. It is completely insoluble in water. Any water that condenses in the degreaser at night is soon evaporated to steam before the solvent reaches its boiling point (250°F). This high boiling point also permits a longer cleaning cycle than possible with trichloroethylene because of the longer time required to reach temperature equilibrium. The vapor of tetrachloroethylene is six times heavier than air, thus restricting the loss of vapor. This permits construction of portable, air-cooled degreasers. Tetrachloroethylene is less toxic than trichloroethylene, but it must be handled with reasonable care. Strong vapor concentrations will result in symptoms similar to those caused by trichloroethylene, which is prohibited for DOD use. Tetrachloroethylene is more stable and requires no stabilizers. It is nonflammable and will only decompose at extremely high temperatures. It does not remove fingerprints, rust, or scale.

#### ***Equipment Used in Solvent Cleaning***

The equipment required for solvent cleaning includes petroleum solvent tanks, portable solvent degreasers, and solvent spray washers.

#### ***Solvent Tanks (figure 2-4)***

Solvent tanks are simply constructed but must be capable of holding the solvent. Where cleaning is conducted at an established installation, special safety features are required in the tank design. Tanks are constructed of low-carbon steel and are welded at the seams. A typical solvent tank with safety features consists of a rectangular compartment, with a tight fitting

cover held open during cleaning operations by means of a chain containing a fusible link. This is held together by a low-melting solder. Should the solvent catch fire, the heat evolved melts the solder and allows the lid to close and smother the fire. For this reason, it is important that the fusible link should always be in an operable condition. The lid should never be wired or fastened so that it cannot close automatically in case of fire. Tanks must be provided with a ground connection to carry off any static charges of electricity.

### ***Improvised Solvent Tanks***

In the absence of approved cleaning equipment, solvent cleaning can be done in drums, pails, cans, or other containers. Fifty-five-gallon drums split in half make suitable tanks for field expedience. Regardless of the container used, provision must be made to keep it closed when not in use.

Other types of solvent spray cleaners are shown in figure 2-5.

### ***Safety Precautions of Solvent Cleaning (figure 2-6)***

When not in use, covers must be kept in place on all solvent tanks. To prevent the accumulation of flammable vapor and the build up of an explosive mixture, adequate ventilation must be provided, especially if paint thinner is used. Carbon dioxide fire extinguishers must be located in the vicinity, and personnel must be trained in their use. A fire blanket should be located nearby. Solvents remove natural oils and may cause skin irritations. Some people are susceptible to the solvent and are afflicted with blisters and chapped skin upon exposure. Operators should wear oil-resistant rubber or plastic gloves and work aprons during cleaning operations to protect themselves and to keep the items free from fingerprints. High vapor concentrations of these solvents may cause dizziness, fainting, and nausea, if inhaled.

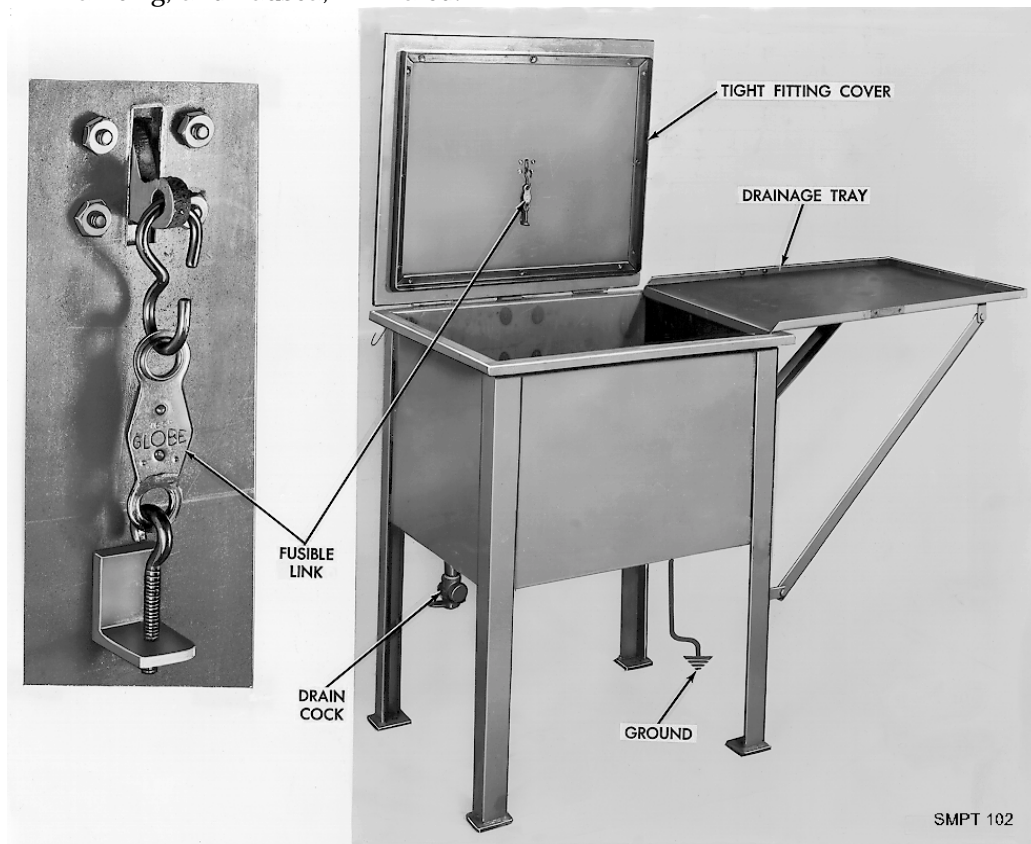
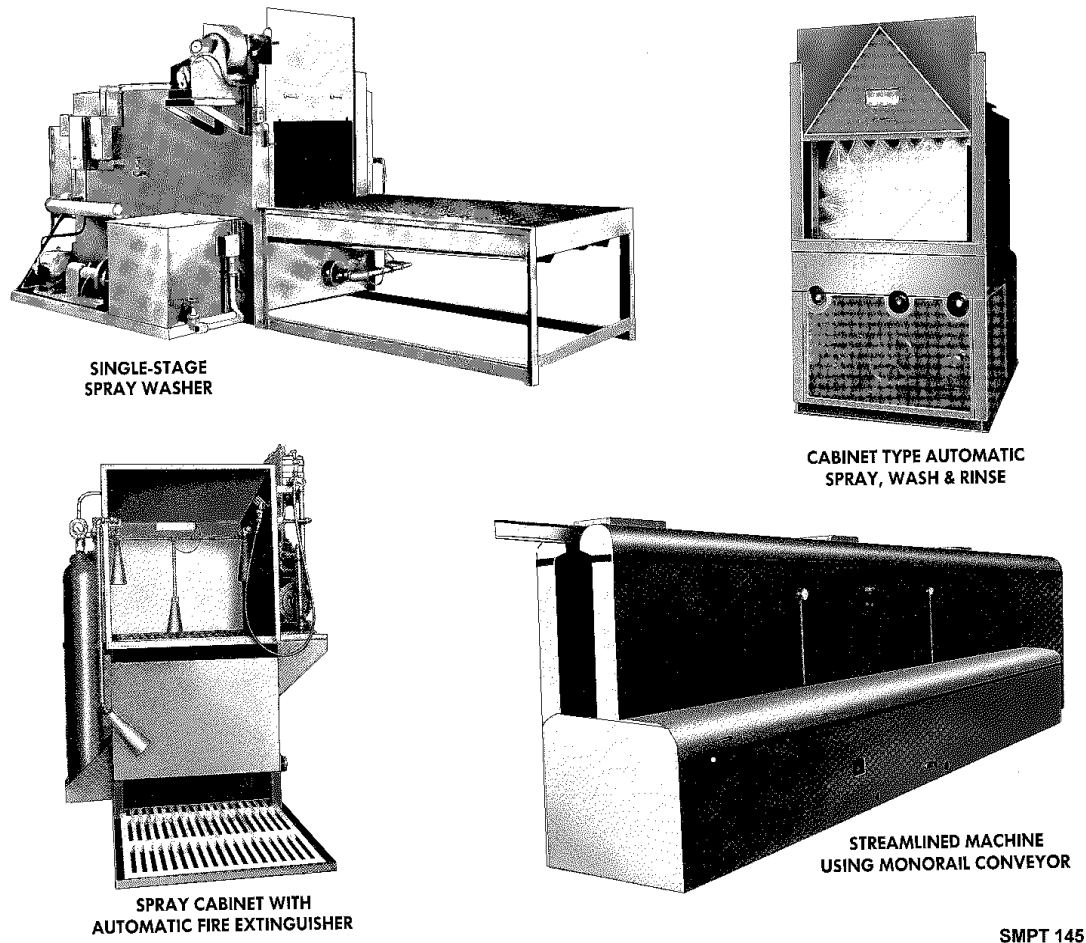


Figure 2-4. Solvent safety tank.



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Figure 2-5. Solvent spray cleaners.

#### SOLVENT CLEANING METHODS

**Immersion (figures 2-7 and 2-8).** The solvent cleaning immersion operations are as follows:

- X Wear safety goggles, rubber gloves, and apron.
- X Immerse items in solvent.
- X Agitate items thoroughly. Position items to receive the most effective washing action.
- X Use a brush where necessary to remove dirt.
- X Remove items from tank when visually clean.
- X Drain completely, allowing excess solvent to return to the tank.
- X Immerse items in a second tank of clean solvent.
- X Agitate as necessary.
- X Place items on tray to drain.
- X Apply appropriate cleanliness tests.

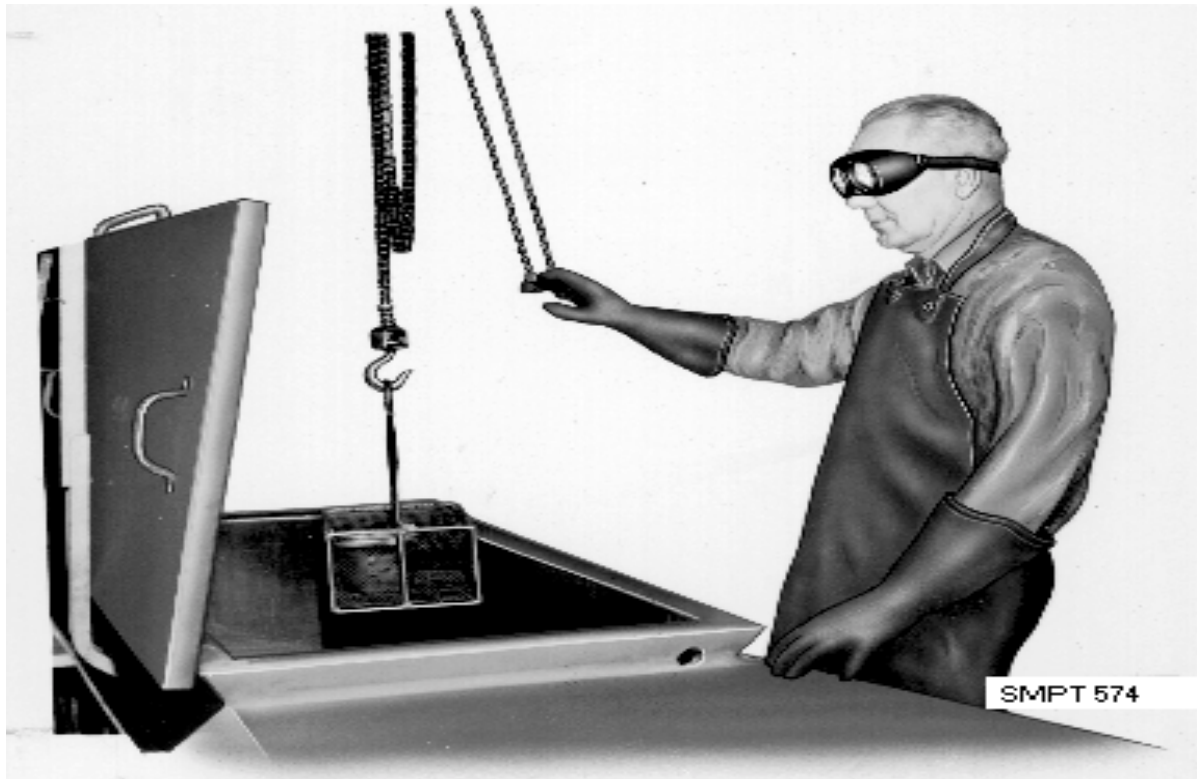


Figure 2-6. Solvent safety clothing.

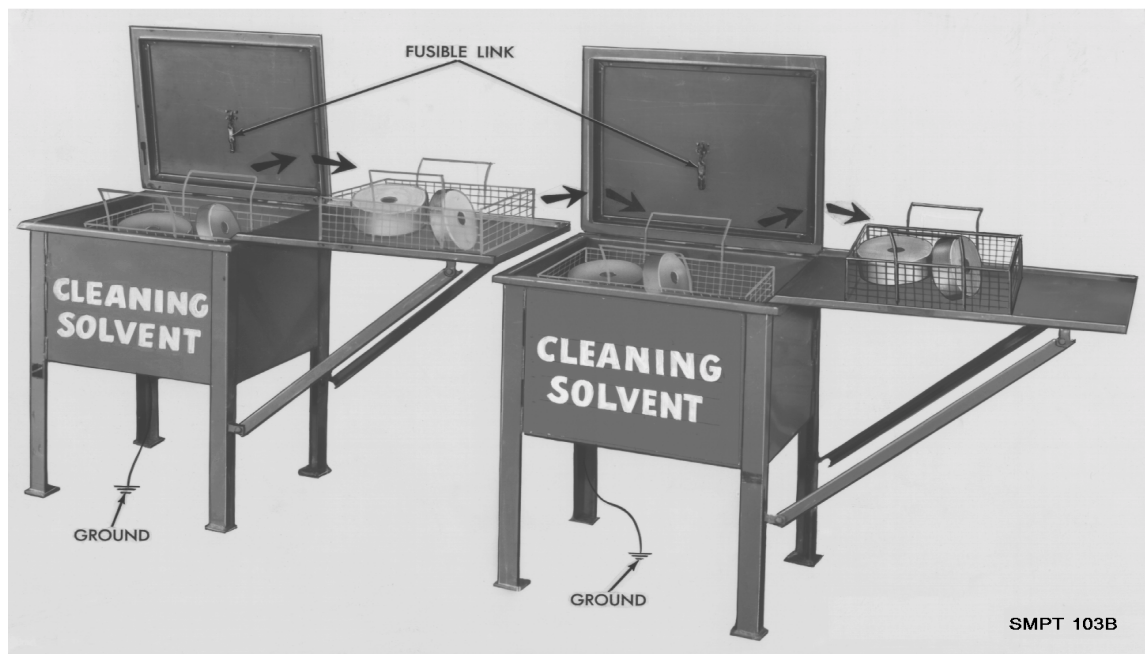


Figure 2-7. Solvent cleaning by immersion.

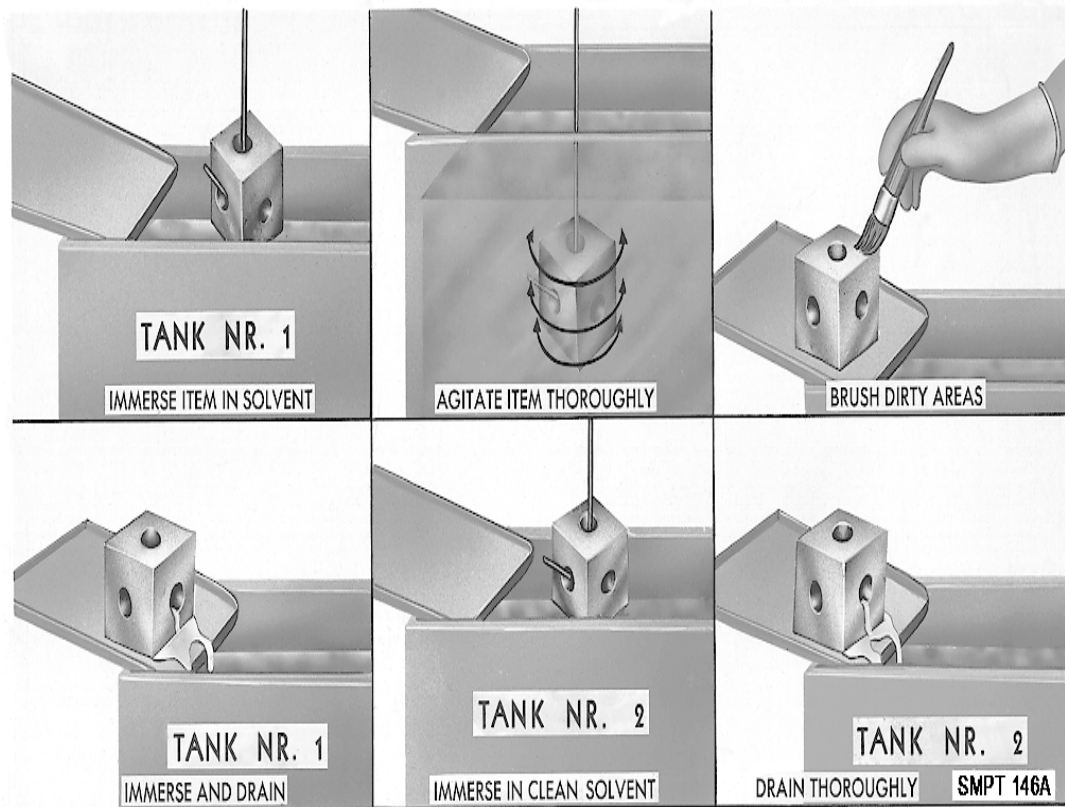


Figure 2-8. Solvent immersion operations.

**Scrubbing and Wiping (figure 2-9).**

When cleaning items that are too large for available cleaning tanks, or because it is impractical to clean by immersion or spraying, the sequence of operations is -

- X Wear safety goggles, rubber gloves, and apron.
- X Soak cleaning cloth or brush in clean solvent.
- X Apply cleaning cloth or brush in clean solvent.
- X Use a combination of soaking, scrubbing, and wiping as necessary.
- X Rinse off area with a clean cloth soaked in clean solvent. Flush over cleaned area and rinse.
- X Drain, shake, or wipe off excess solvent.
- X Apply appropriate cleaning tests.

**Spraying (figure 2-10)**

If items are of simple construction and free of cavities and indentations, and if the equipment is available, the solvent spraying steps are -

- X Wear rubber gloves, goggles, and apron.
- X Load items into solvent spray area.
- X Turn on spray pump and direct nozzle at items.
- X Shift items in basket so spray reaches all areas.
- X Remove items from spray zone and permit to drain.
- X Apply appropriate cleaning tests.



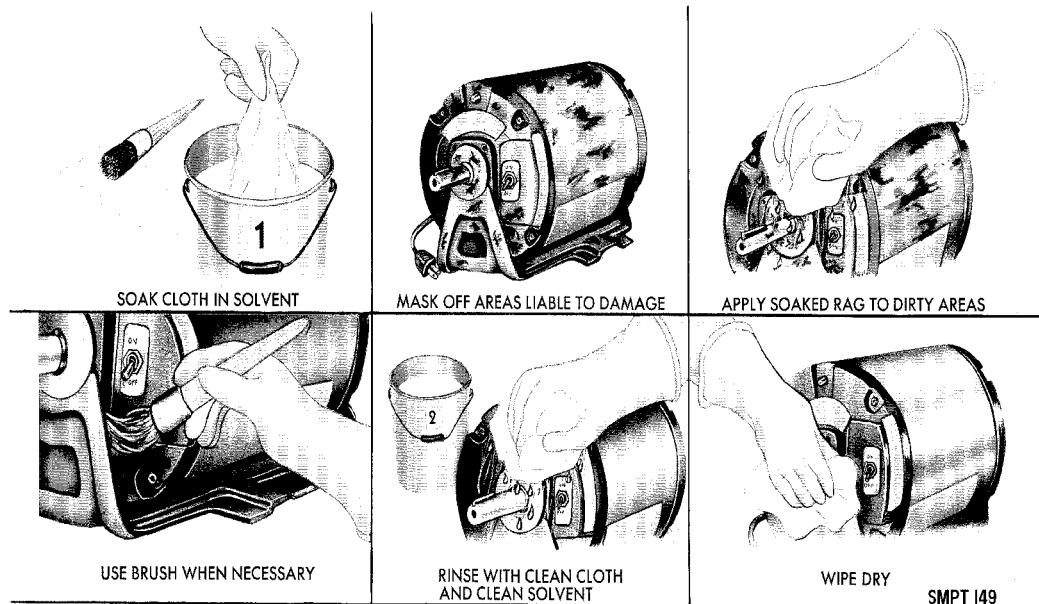


Figure 2-9. Solvent scrubbing and wiping.

**PERSPIRATION AND FINGERPRINT REMOVAL**

Perspiration and fingerprint removal equipment and processes are depicted in figures 2-11 and 2-12. All items with critical functioning surfaces or with close tolerances must be cleaned in perspiration and fingerprint remover until they will pass the cleaning tests as specified in MIL-STD-2073-1C. Items are treated for fingerprint removal (figure 2-12) by the following steps:

- X Wear safety goggles, rubber gloves, and apron.
- X Immerse items in perspiration and fingerprint removal compound.
- X Agitate items for a minimum of 2 minutes.
- X If item is too large for complete immersion, clean critical surfaces with a lint free clean cloth saturated in fingerprint remover.
- X After the petroleum base fingerprint remover (MIL-C-15074) is used, rinse items in a second tank containing clean solvent conforming to A-A-2904, ASTM D 4081, ASTM D 4376 (grade 1), P-D-680 or MIL-T-81533, to remove the fingerprint residue.
- X Agitate items in rinse solvent for at least 2 minutes.
- X After rinsing, drain items thoroughly.
- X Apply appropriate cleanliness tests.

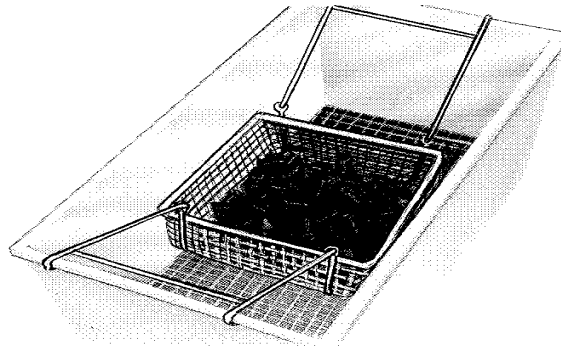
Solvent cleaning followed by fingerprint removal is shown in figure 2-13. The steps given previously for solvent cleaning followed by the steps for fingerprint removal are the same as the steps in vapor degreasing cleaning.

**VAPOR DEGREASING**

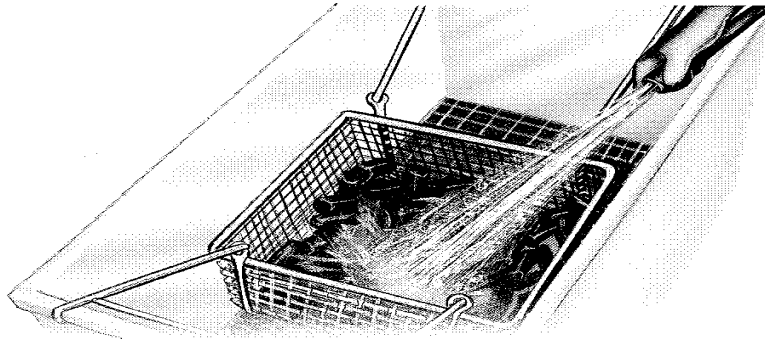
The basic principles of vapor degreasing are shown in figure 2-14. Vapor degreasing is used for the rapid and thorough removal of heavy oils and greases from most metal products. It utilizes the vapor of special grades of non-flammable, chlorinated solvents. When an oily, greasy item is lowered into the vapor, the vapor condenses on the item and the resulting hot liquid rapidly dissolves and rinses away the contaminants. As the item reaches the same temperature of the vapor, condensation ceases and cleaning stops. The degreasing process is quite simple, but must be performed only in specially designed equipment because of the health hazard involved. Operating rules as outlined in manufacturers' manuals must be strictly followed. This procedure is being replaced by a less environmentally hazardous procedure which will be discussed later in this chapter. See paragraph entitled "Restrictions in the Use of Solvents."



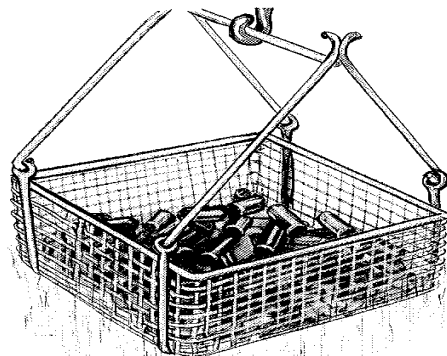
**LOAD ITEMS IN WORK BASKET**



**LOWER BASKET INTO SPRAY TANK**



**DIRECT NOZZLE AT ITEMS**



**REMOVE BASKET — ALLOW TO DRAIN** SMPT 152

Figure 2-10. Solvent spray cleaning.



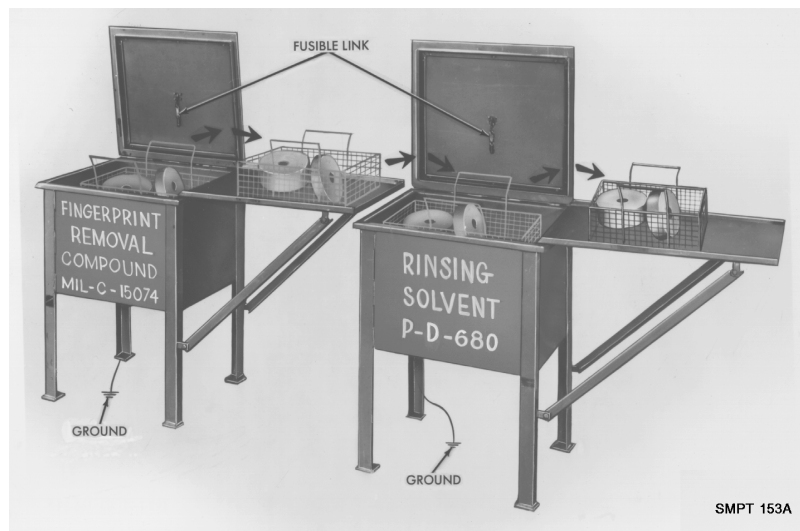


Figure 2-11. Perspiration and fingerprint removal.

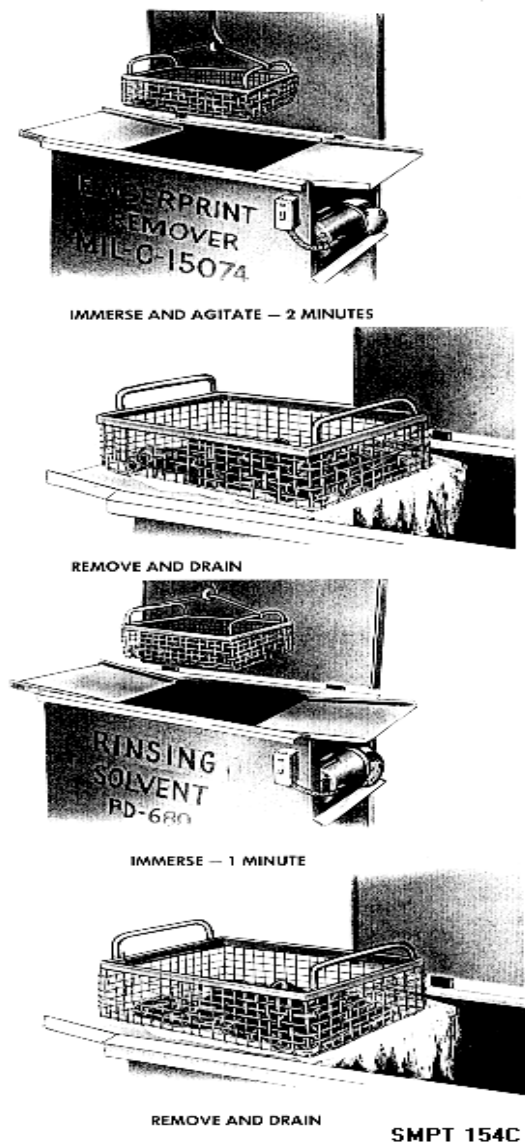


Figure 2-12. Fingerprint removal operations.

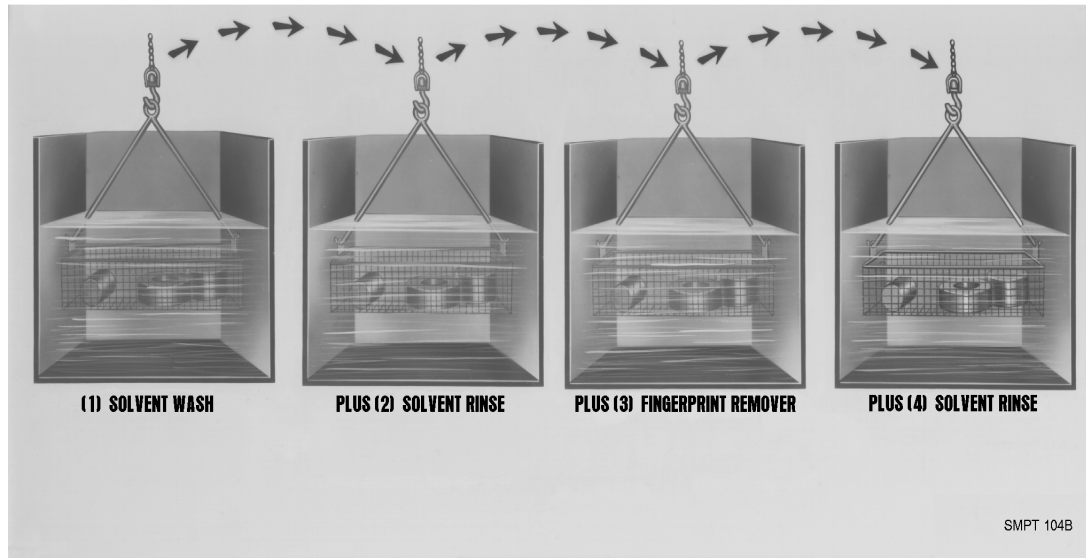


Figure 2-13. Solvent cleaning followed by fingerprint removal.

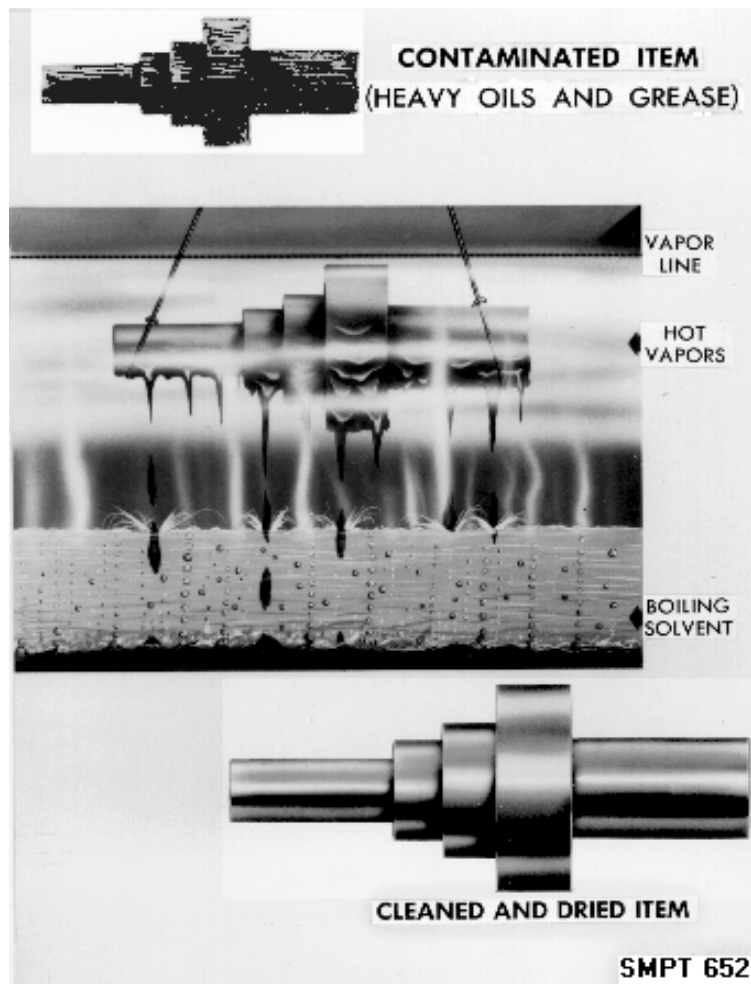


Figure 2-14. Vapor degreasing principle.

## **VAPOR DEGREASING FOLLOWED BY FINGERPRINT REMOVAL**

Items will be cleaned in accordance with the vapor degreasing process followed by the fingerprint removal process as detailed in this chapter.

### **Applicability**

This process is used whenever the temperatures involved will not result in damage, injury, or malfunction of the item. Vapor degreasing is extensively used because of the ease and rapidity of removal of oils and greases from metal items of simple construction. The items are clean, dry, and ready for preservation and packing as soon as they are removed from the degreaser and allowed to cool. The process is economical, once the equipment is installed, and use is made of solvents that are free from fire hazards.

### **Vapor Degreasing Materials (solvents)**

One of the materials used for vapor degreasing is a product of the chemical industry known as technical tetrachloroethylene (perchloroethylene) (ASTM D 4081, ASTM D 4376) and known as chlorinated solvent.

### **Restrictions in the Use of Solvents**

Care shall be taken to assure that when these solvents are used, aluminum surfaces are not adversely affected by depletion of inhibitors or decomposition of the solvent.

Any cleaning material used in the process must be selected to comply with Section 236 of Public Law 102-484 which prohibits the Government from awarding any contract which includes a specification or standard that requires the use of a Class I ozone-depleting substance identified in the Clean Air Act Amendment of 1990. The Federal and military specifications O-T-620, MIL-T-81533, and MIL-C-81302, are Class I ozone-depleting substances and should not be used. Substitute materials such as ASTM D 4081, ASTM D 4376, A-A-2904, or those which conform to ASTM D 4081 and ASTM D 4376 are free of ozone depleting materials and should be used. Preservatives, as well as cleaning materials, must be in compliance with the previously mentioned law.

Some of the solvents may not have "ozone-depleting" characteristics, but they may have some other environmentally unsafe attributes which render them undesirable for continuing use. P-D-680 is one of those solvents and will be mentioned later under the paragraph "Environmentally Safer Cleaning Methods". The practice of vapor degreasing by utilizing traditional chlorinated solvents is decreasing and will eventually be supplanted by a less environmentally hazardous procedure. The use of chlorinated solvents in vapor degreasing has been banned entirely in the State of California. There are various aqueous-based solvents available through the GSA sources, but there are none (for vapor degreasing) to this date, that have reached the level of efficiency comparable to the old chlorinated solvents for vapor degreasing. Testing of new solvents continues, of course. See the paragraph later in this chapter entitled "Environmentally Safe Solvents."

### **Equipment Used in Vapor Degreasing (figure 2-15)**

Vapor degreasing should be performed only in properly designed and controlled equipment. The manufacturer's guide to operations must be carefully followed. Degreasers vary greatly in size and complexity, but they all have basic components that are included in all units. A vapor degreaser in its simplest form consists of the following components:

- X Heating elements (A). A source of heat designed to raise the temperature of the solvent to the boiling point.
- X Boiling chamber (B). A tank or vat capable of holding the solvent.
- X Vapor area (C). A work space between the surface of the boiling solvent and the top of the condenser, large enough to hold the vapor and accommodate the work.

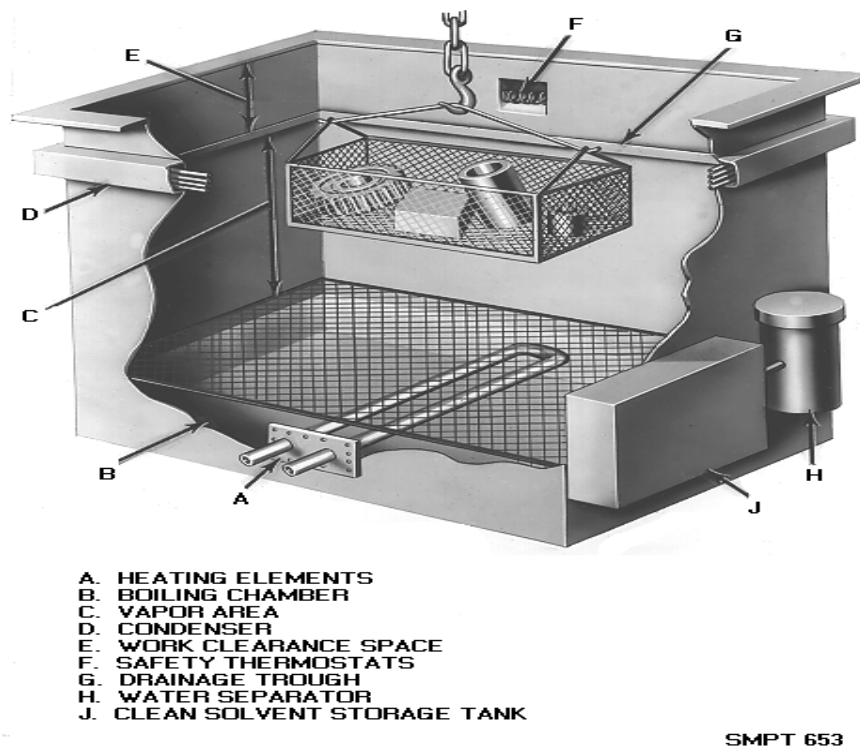


Figure 2-15. Basic vapor degreaser.

- X Condenser (D). The water jacket and coils used to balance the heat input and condense the vapor. (Degreasers designed for tetrachloroethylene only may be without a condenser. The walls of the tank are correspondingly higher to provide for air cooling.)
- X Work clearance space (E). Additional wall height above the condenser prevents normal air currents from pulling vapor from the degreaser.
- X Safety thermostat (F). This shuts off the heating elements if the vapor should rise above the condenser.
- X Drainage trough (G). This collects the condensed solvents from the walls and delivers them through the water separator to the storage tank or boiling chamber.
- X Water separator (H). This collects moisture, condenses it and separates it from the solvent.
- X Clean solvent storage tank (J). Where the returning solvent can be held or returned to the boiling chamber.

### Operating Characteristics

The solvent in the boiling chamber is heated by the heating elements until boiling begins and vapor rises into the vapor area. As the vapor reaches about midpoint of the condenser, it begins condensing along the walls of the degreaser. The condensed solvent then flows into the draining trough and back to the water separator where any moisture in the solvent is trapped and removed as necessary. From the separator, the solvent returns to the clean storage tank or back into the boiling chamber. If the condenser cooling water supply should fail during operations, the rise of vapor above the tank is prevented by a safety thermostat which automatically turns off the heating coils. Another thermostat is often located just above the heating coils to turn the heat on again when the vapor level drops too low.

### Types of Vapor Degreasers (figure 2-16)

Vapor degreasers are manufactured in many sizes and shapes, ranging from small, batch-type, manually operated models, to huge, continuous, fully

automatic, conveyORIZED installations. Vapor degreasers may be heated by gas, steam, or electricity. They may be designed for use with trichloroethylene or tetrachloroethylene only, or they may be capable of using either solvent.

There are manually operated, water and air-cooled degreasers; manually operated, flush vapor degreasers; manually operated, two- and three-dip vapor degreasers; and several designs of conveyORIZED vapor degreasers, which incorporate various special features. Several types of vapor degreasers are illustrated in figure 2-16.

## Installation

Vapor degreasers must be installed to keep solvent vapor loss to a minimum. The degreaser should, therefore, be located away from abnormal air currents such as heating and ventilating equipment, open windows and doors, and out of direct line of any air flow or down drafts. Air exhaust systems should be provided only when necessary, such as required for a pit-installed vapor degreaser. A degreaser should not be located near open flames, any high temperature surfaces (above 750°F), or where direct sunlight will reach the vapor zone. Flames, sunlight, high temperature, and water will cause decomposition of the degreasing solvent. Decomposition products are toxic and corrosive gases. They are extremely dangerous to personnel and cause rapid rusting of equipment within a considerable area of the degreaser.

## Miscellaneous Equipment

Other equipment that is necessary for efficient degreasing operations include storage tanks for retention of contaminated solvent, metal safety containers for the storage of cleaning rags, mops or absorbent materials, a solvent recovery still, and, where required, an air exhaust system.

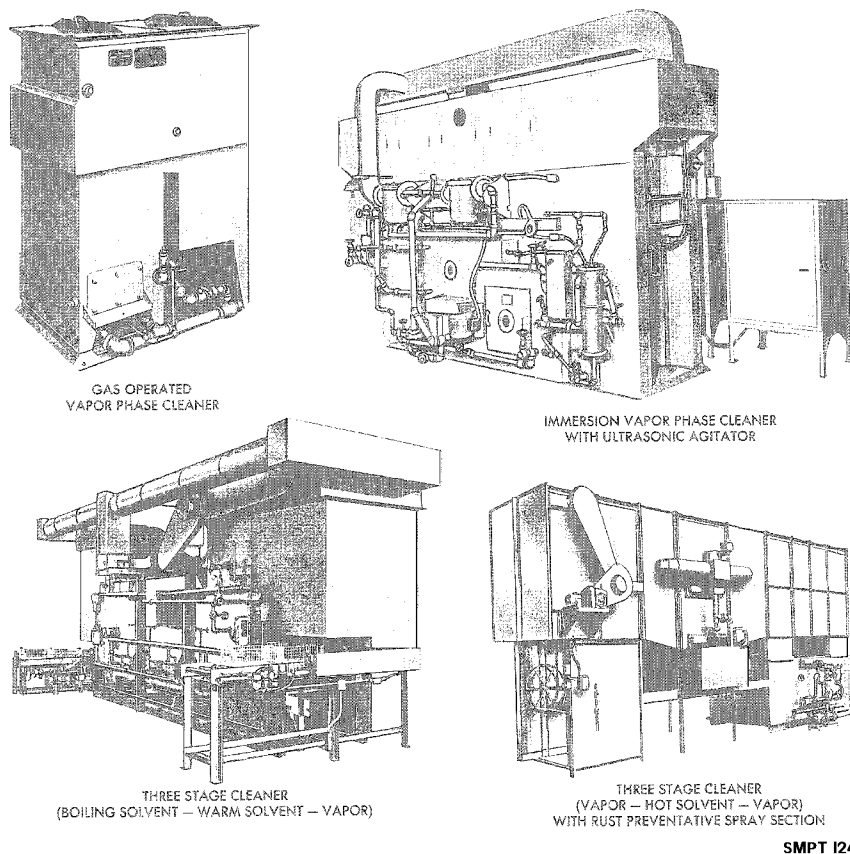


Figure 2-16. Types of vapor degreasers.

## **SAFETY PRECAUTIONS OF VAPOR DEGREASING**

### **Solvent Hazards**

Degreasing solvents are narcotic and produce a feeling of exhilaration and intoxication similar to the more pleasant phases of alcoholic intoxication. Do not overexpose anyone to the vapor. Overexposure to the vapor may produce nausea, dizziness, headaches, and general ill feeling. Skin contact with the solvent removes natural skin oils resulting in excessive dryness and subsequent cracking and chapping of the skin. Solvent absorption through the pores may produce effects similar to breathing the vapor. These solvents decompose at high temperatures, producing gases that are very dangerous and corrosive. Attempts to neutralize an acid condition by using alkalies is also particularly dangerous. This will result in an explosive mixture.

### **Handling Solvents**

Keep all solvent containers, drums, and storage tanks closed to avoid evaporation and vapor contamination of the area, except when using. Provide a pump for solvent transfer from storage containers to the degreaser. Never use buckets or pails for the transfer. This invariably leads to splashing and spillage. Clean up any spilled solvent immediately after adequately protecting yourself with safety equipment. Do not use forced air to dry up spills as this increases air contamination. Use mops, rags, or other absorbing materials to soak up the solvent, place them immediately in closed metal containers and remove for drying. Transport and store sludge and used solvent in closed drums.

### **Protective Equipment**

Personnel who use the degreaser should obtain protective equipment, maintain it in good condition, and replace it as soon as it becomes worn or unsafe. The following items of personal protective equipment should be furnished, consistent with the hazards involved:

- X Solvent-resistant gloves and aprons (fabricated from, or impregnated with polyvinyl chloride or neoprene plastics).
- X Chemical safety goggles, and acid-type goggles, where there is any possibility of splashing.
- X Hose masks, with hose inlet in a vapor free atmosphere; or air line masks with proper reducing valve and filter for use where conditions will permit safe escape if the compressed air supply should fail.
- X Self-contained breathing equipment with stored oxygen or air.
- X Rescue harness and lifelines.

### **Safety Rules**

If solvent is properly handled, and equipment well designed, maintained, and operated, health hazards will be at a minimum. The following rules must be posted and observed by all operators.

- X Know your equipment and its operation.
- X Do not smoke near a degreaser. Inhaled vapor breaks down into acidic components by the heat of cigarettes.
- X Handle all solvents in closed containers. Use pumps and pipelines to make transfers of liquid.
- X Maintain the vapor within the degreaser by careful operation.
- X Never spray solvent above the vapor level, thus driving vapor into surrounding area.
- X Do not lower work too rapidly into the vapor area, thus driving out vapor.
- X Do not bring open flames, hot surfaces, or open electric heaters near the vapor.
- X Do not permit the cleaning of clothing in the vapor degreaser. The vapor remains entrapped in the fabric and may result in serious blisters.
- X If a unit must be entered for cleaning, do so only after all solvent liquid and vapors have been removed or dissipated, and then only if at least one other workman is in attendance on the outside. A workman entering a machine for any purpose should wear a mask which provides a source of outside air.

**Selection of Items for Degreasing**

Nonporous items of simple construction should be selected for vapor degreasing. Porous organic materials such as leather, rubber, and fabrics may be damaged by the heat and the solvent action. Items joined with low-melting solders may be injured by tetrachloroethylene degreasing.

**Starting the Degreaser**

Before starting the degreaser, the operator must perform the following:

- X Check the degreaser and all pipelines for any evidence of leaks.
- X Check the solvent level. It must be above the heating elements, the depth (2 to 4 inches) as specified by the manufacturer.
- X Check the condition of the solvent. Determine its acid and sludge content.
- X See that water, heat, and power sources are available for full operation.
- X After making certain that the degreaser and equipment are in readiness, open the shutoff valve to the condenser and water separator precooler water line, if the degreaser is equipped with a precooler.
- X Turn on the power for auxiliary equipment.
- X Start the heating unit. For steam heated degreasers, open the stem valve slowly and permit a gradual buildup of steam. On electrically heated degreasers, turn the heat switch to the ON position. With gas-fired degreasers, follow manufacturer's manual for lighting the burners.
- X After starting the degreaser, but before commencing operations, check and adjust the cooling water temperature. Allow the vapor to reach the midcenter of the condenser coils and then adjust the water supply so that the temperature at the discharge end is slightly warm to the hand (90° to 120°F).
- X Raise the cover slowly to minimize vapor disturbance. Check for vapor buildup by observing the presence of a wet line along the degreaser walls at the condenser level.

**Degreasing With Vapor Alone (figure 2-17)**

Items to be cleaned by vapor alone should be of simple construction and lightly contaminated. Perform the following degreasing steps:

- X Lower items slowly into the vapor area at a rate of not more than 12 feet per minute.
- X Suspend items from hooks, racks, or in baskets so that the liquid, as it condenses, can drain off without collecting in pockets or crevices. When the vapor stops condensing on items, the cleaning has stopped and items are ready for removal.
- X Remove items slowly from the vapor area. If items are of small mass and heavily coated, some soil may still remain. This requires a second pass through the vapor. Hold items briefly above the vapor level for cooling. When items have cooled slightly, return to the vapor area to complete the cleaning.
- X Keep items above the vapor line long enough for the liquid solvent to drain back into the degreaser.
- X Remove from degreaser.
- X Apply appropriate cleanliness tests.



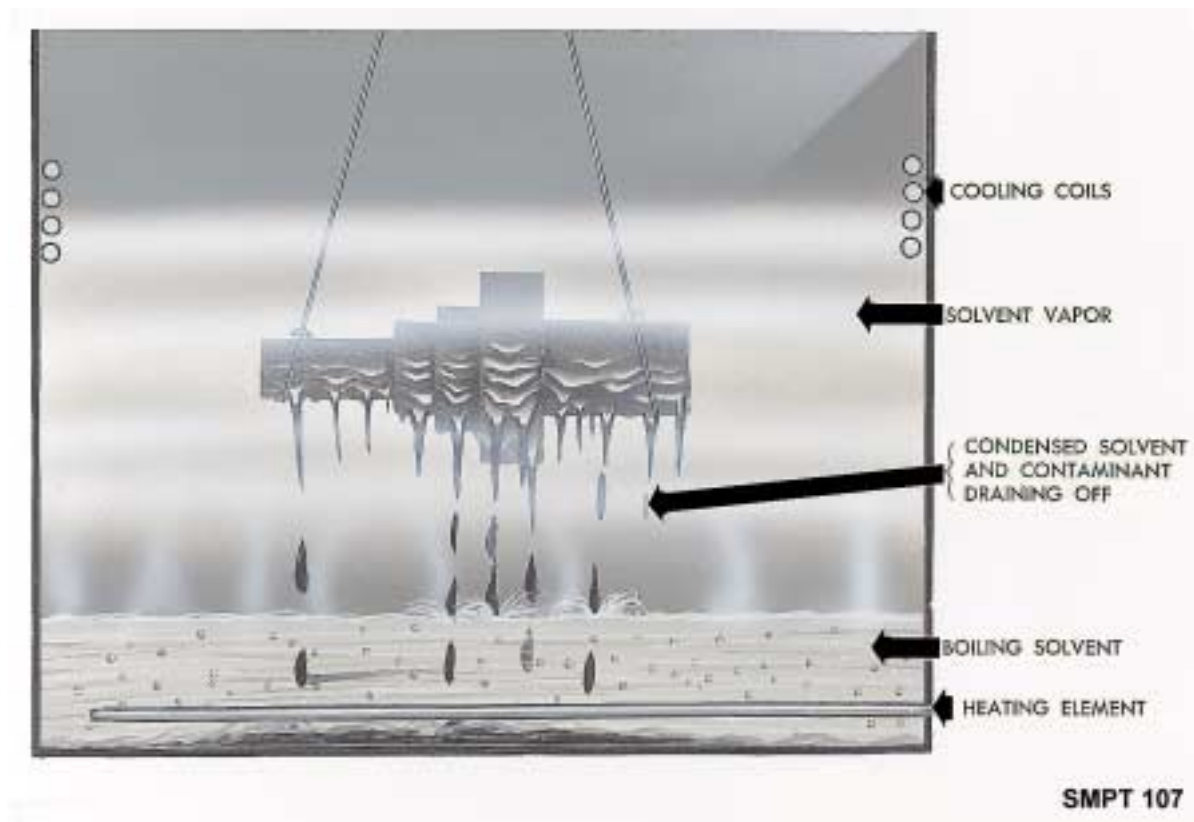


Figure 2-17. Degreasing with vapor alone.

#### **Degreasing With Vapor and Spray Cycle (figure 2-18)**

When contaminants on items include solid particles such as chips, dust, or turnings, and equipment is available, the use of a spray nozzle is advisable.

#### **Degreasing With Warm Liquid-Vapor Cycle (figure 2-19)**

Items which heat up too rapidly and slow down the rate of condensation are effectively cleaned using an extra warm or hot solvent tank. The warm tank is suitable for small items closely packed together. The liquid penetrates into blind holes and recesses dissolving and loosening the dirt. The method is suitable for the removal of flammable solvents and low boiling point oils from items, before subjecting them to the high vapor temperatures.

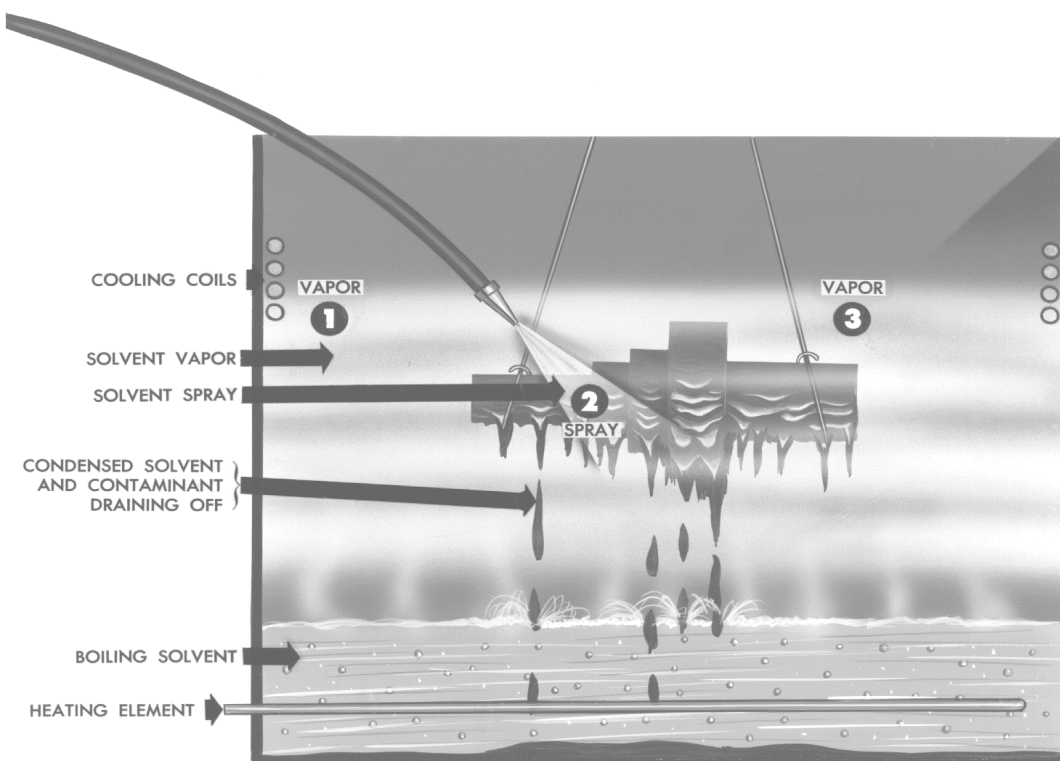
#### **Degreasing With Boiling Liquid-Warm Liquid-Vapor Cycle (figure 2-20)**

This cycle of cleaning is used where complex oils, greases, waxes, and similar difficult contaminants are to be removed. The surging action of the boiling solvent loosens caked-on contaminants and penetrates hard-to-reach crevices.

#### **ALKALINE CLEANING PROCESSES**

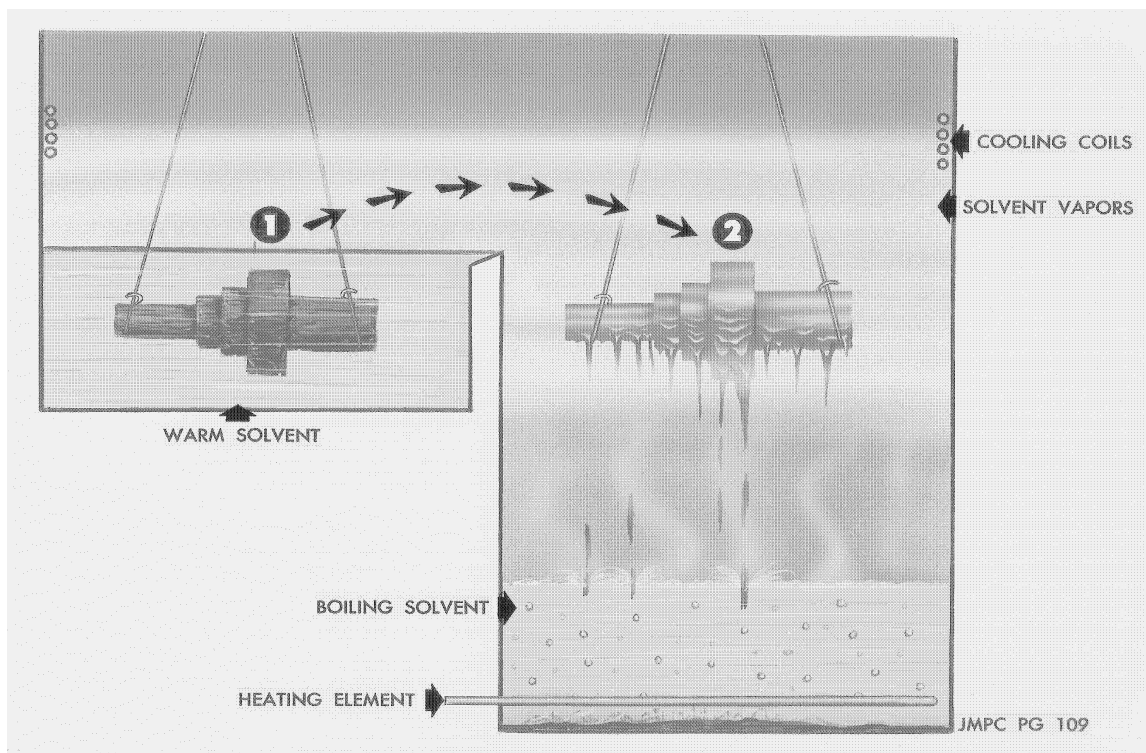
Alkaline cleaning will remove shop dirt, soil, oily and water-soluble contaminants, and heavy waxes and buffing compounds. Highly alkaline solutions are used for heavy-duty cleaning of steel, and the more moderately buffered solutions are employed for aluminum and for aluminum and zinc base castings. Almost all manufacturing contaminants, except tightly adhering, insoluble compounds such as chalk, etching inks, heavy rust, and mill scale are removed. Some alkaline derusting processes will even remove light rust.





SMPT 108

Figure 2-18. Vapor-spray-vapor cycle.



JMPC PG 109

Figure 2-19. Warm liquid-vapor cycle.

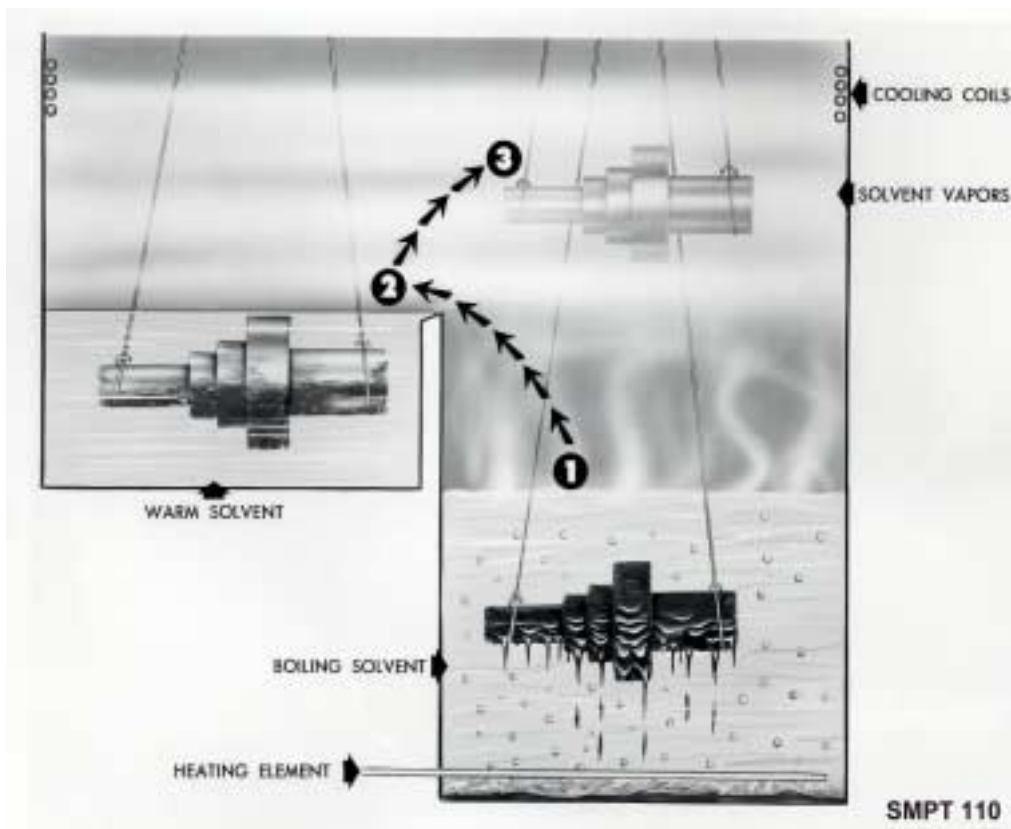


Figure 2-20. Boiling liquid-warm liquid-vapor cycle.

### Applicability

If items are of simple construction, have noncritical surfaces, and are composed of iron and steel, they can be effectively cleaned by the alkaline cleaning processes with an assurance that they will be thoroughly cleaned, uninjured, free from cleaner residues and fingerprints, and capable of passing the required test. Metals cleaned in alkaline cleaning solutions must afterwards be thoroughly rinsed in hot water at 180°F. A rinsing procedure that fails to remove residual alkali will give unsatisfactory results.

### Materials

Alkaline cleaners have become highly specialized and a great variety of compounds for specific cleaning jobs are available. Follow the supplier's recommendations when using these compounds. Alkaline cleaners are composed of mixtures of alkaline salts which loosen the soil for easy washing, plus small amounts of soap increasing cleaner penetration and buffering compounds for maintaining the alkalinity in the presence of acid-type contaminants that tend to neutralize the cleaner. The amount of soap present depends upon the type of equipment used and the hardness of the water. For example, alkaline cleaning by immersion requires more soap than pressure spray cleaning. This is because the pressure spray cleaning produces excessive foaming unless the soap concentration is reduced, so less soap is required.

#### ***Compound, Alkali, Boiling Vat (Soak) or Hydrosteam (A-A-59146)***

Alkaline cleaning compound A-A-59146 comes in one grade for use in the hot soak tank cleaning of ferrous and nonferrous parts. It is also used in hydrosteam units operating on existing steam supply for steam cleaning.

#### ***Cleaning Compound, High Pressure (Steam) Cleaner (A-A-59133)***

This cleaning compound is for use in steam cleaning machines for cleaning ferrous and nonferrous surfaces. Type I compound contains phosphates while type II compound does not.

***Alkaline cleaning compound for steel (SAE AMS 1547)***

Alkaline cleaning compound is required for steel. AMS 1547 is used when a heavy-duty anodic electro-cleaner is required.

**Equipment**

The equipment necessary for alkaline cleaning may vary with the process, but it must be capable of providing sufficient heat to maintain a boiling solution. There are several designs of cleaning machines equipped to furnish heat by gas, steam, or electricity. Steam is usually considered the most efficient source of heat.

**Immersion tanks (figure 2-21)**

Hot alkaline cleaning tanks are commercially available in many sizes with capacities ranging from 10 gallons to several hundred gallons. They are furnished with standard equipment consisting of sludge drains, scum gutters, drain valves, hinged covers, dial thermometers, removable grilles, and automatic temperature controls. Tanks are furnished for use with natural, manufactured, and liquid petroleum gas, kerosene, electricity, and steam heat. Under field conditions, tanks may be devised from steel drums, or fabricated tanks which will meet the minimum needs of field operations.

**Alkaline spray washers (figure 2-22)**

These machines are well adapted to large volume operations. The most widely used are the belt conveyor washers, built with cycles from single stage washing to multi-stage processing. These machines are adapted for cleaning many types of items of all sizes and shapes, placed singly or in baskets on a belt. Monorail spray washers carry items through washing, rinsing, and other stages. Some of these washers are arranged for straight line production. Others have a continuous return conveyor for loading and unloading at one station. Batch rotary-drum washers have a cylindrical drum with an interior spiral conveyor to carry work through the drum. The items are loaded in batches, cleaned while the drum rotates in one direction, and finally discharged by reversing the direction of the drum rotation. The rotation platform washers have a circular table that rotates slowly to carry work past washing and rinsing spray nozzles and through a drying section.

**Alkaline electrocleaning tanks (figure 2-23)**

These tanks, designed similar to immersion tanks, are equipped with heating coils and overflow dams. Sheet steel electrodes hang from electrode rods in front of the coils and dams. The electrodes should have the top edges about 3 inches below the normal solution level and porcelain insulators at the bottom edges to prevent contact with the tank sides.

**Safety Precautions**

The health hazards involved in alkaline cleaning are mainly skin irritations produced by the alkaline compounds. A high relative humidity in alkaline cleaning areas will aggravate irritations. Use protective goggles, gloves, and aprons to prevent eye or skin contact with the alkaline compounds. Avoid splashing hot solvents, which may result in burns and blisters.

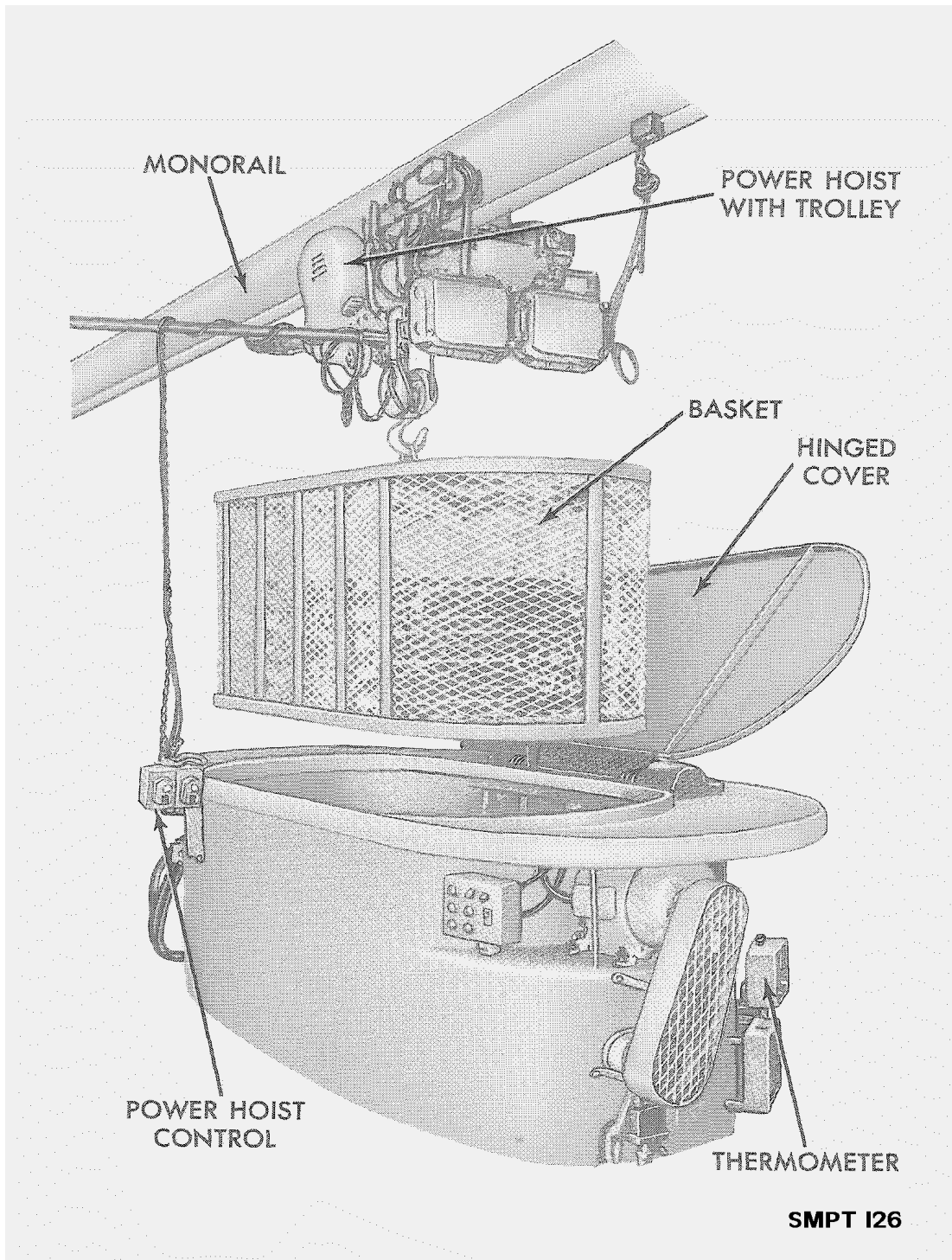


Figure 2-21. Alkaline immersion tank.

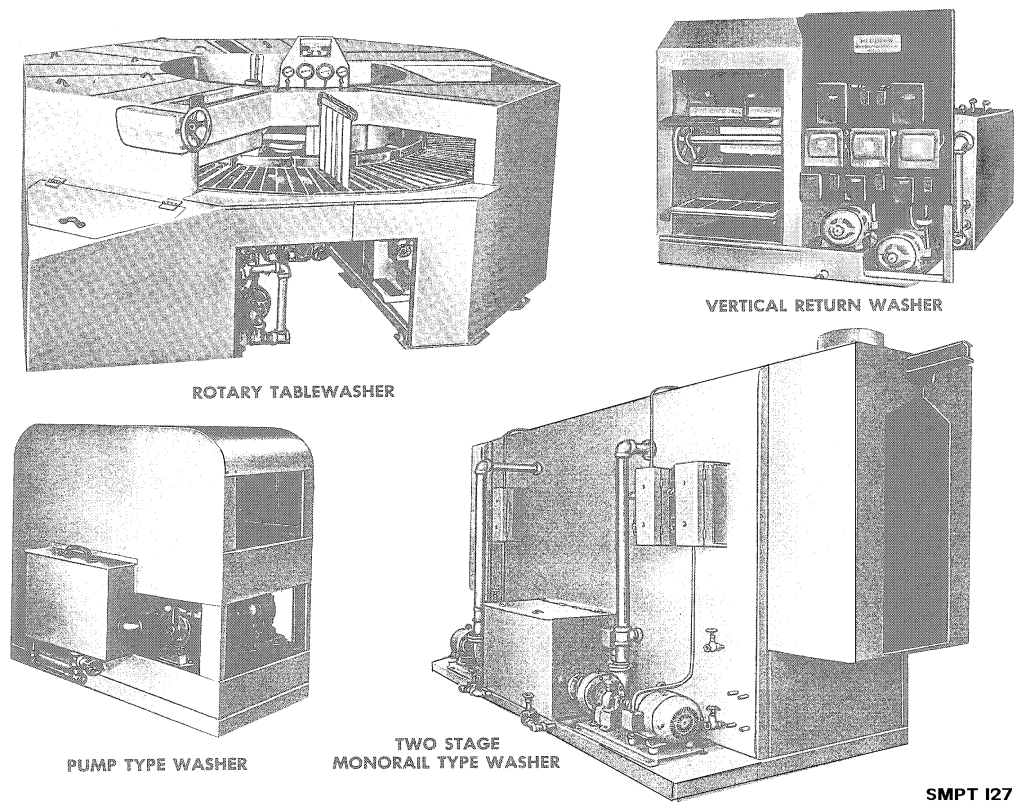


Figure 2-22. Types of alkaline spray washers.

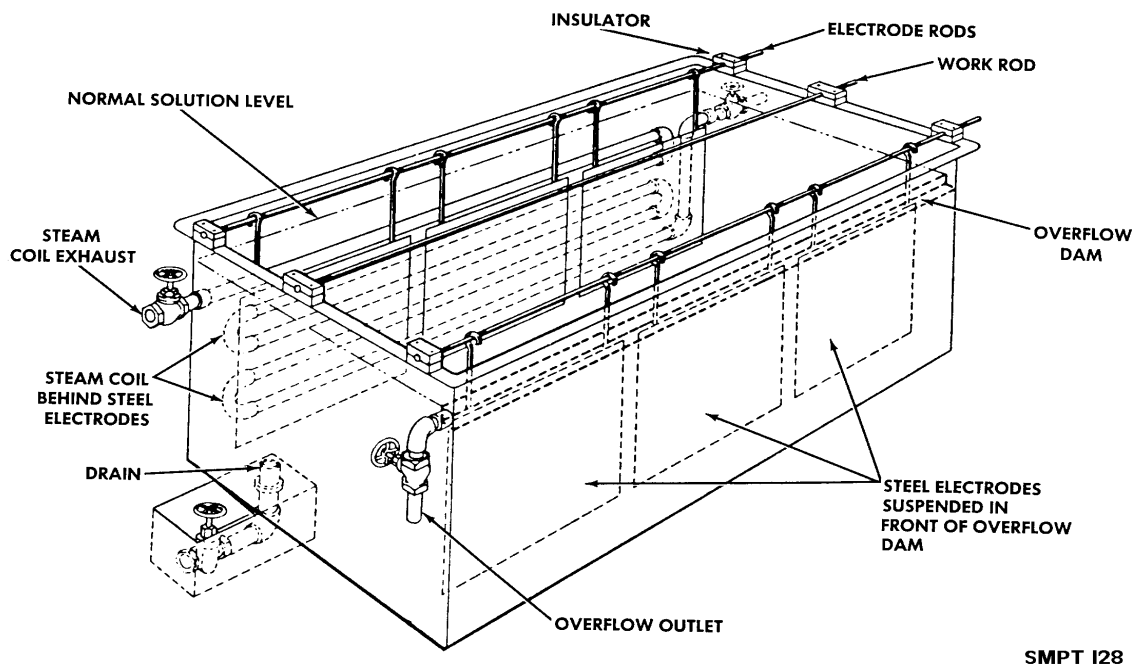


Figure 2-23. Alkaline electrocleaning tank.



**Immersion Technique (figure 2-24)**

This process consists of immersing and soaking items in an alkaline cleaner (A-A-59146) and rinsing in clean water above 180°F. To accomplish alkaline immersion cleaning, perform the following steps:

- X Wear goggles, rubber gloves, and apron.
- X Mix 7 oz. of compound per gallon of water at a rolling boil for soak cleaning. There must be no undissolved material in the tank.
- X Lower items to be cleaned into the hot (205° - 212°F) alkaline solution and allow to soak from 2 to 10 minutes, depending on the degree of contamination.
- X Agitate and brush items to speed up and improve cleaning.
- X Transfer items to the rinse tank, allowing sufficient time for the solution to drain.
- X Rinse items for 30 to 60 seconds in hot water 180°F or above.
- X Drain and dry immediately.
- X Apply appropriate cleanliness tests.

**Pressure Spray Technique (figure 2-25)**

This process consists of subjecting items to a pressure spray of alkaline cleaning solution (A-A-59146) followed by a rinse of hot water above 180°F. Alkaline spray cleaning is performed in mechanical washing machines as shown in figure 2-25. Spray cleaning is preferred to immersion cleaning when contamination on items is heavy enough to require the spray impact for removal. The force of the spray against the items removes both solid particles and soluble contaminants. The steps are-

- X Place items on the washer conveyor so that the sprayed solution can reach all of the surfaces of the item.
- X Adjust sprayer nozzles and conveyor feed for effective cleaning.
- X Pass items through the cleaning, rinsing, and drying stages. If the machine has no separate drying stage, dry items immediately after rinsing by an approved procedure.
- X Apply appropriate cleanliness tests.

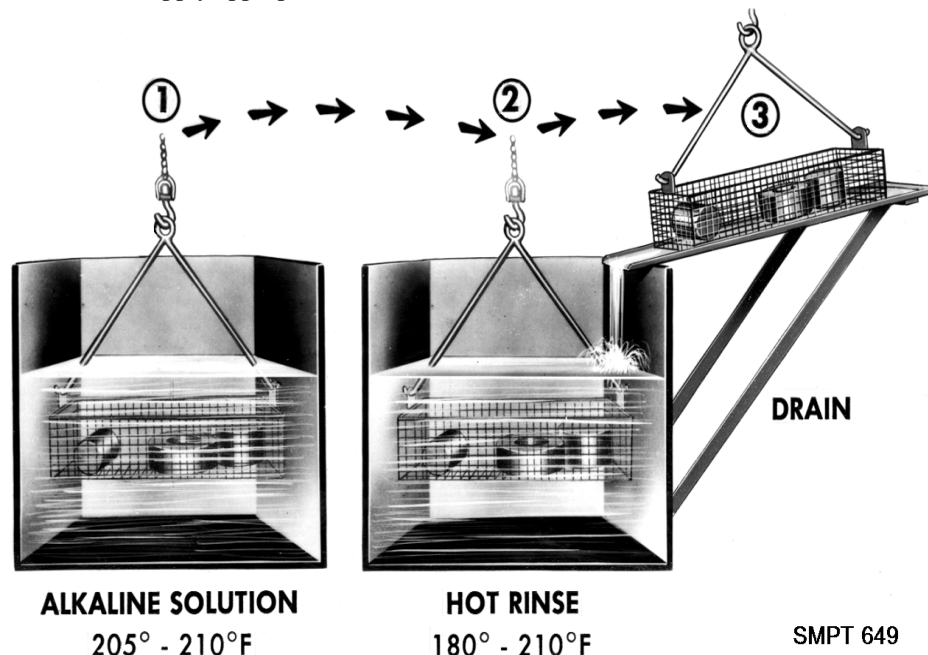


Figure 2-24. Alkaline immersion cleaning.

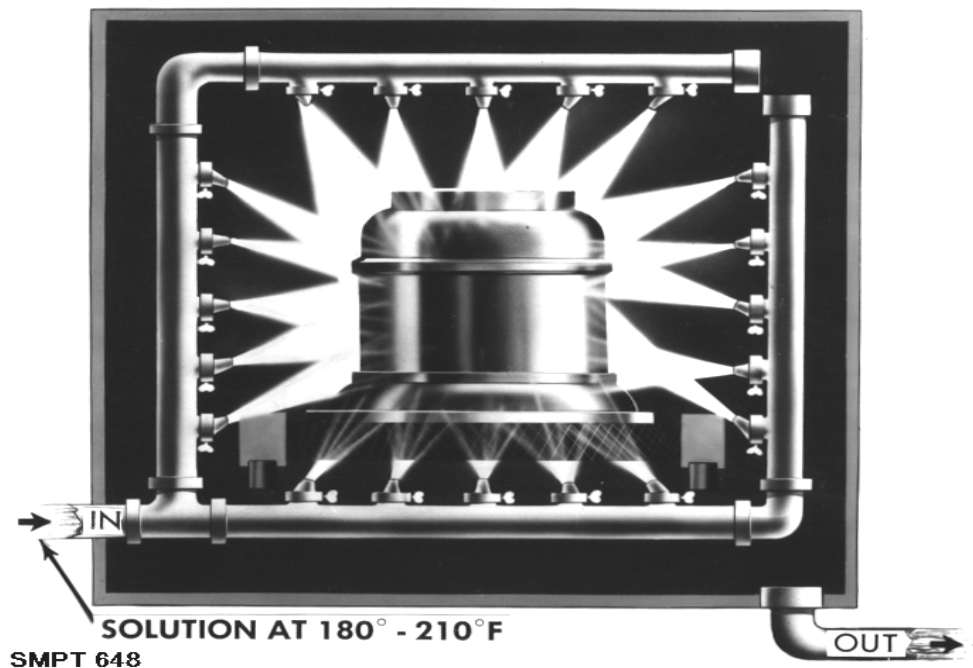


Figure 2-25. Alkaline cleaning by pressure spray.

### Electrocleaning (figure 2-26)

This process consists of immersing items in an alkaline cleaning solution with the item serving as an element of an electrochemical cell. Plater's electrocleaning compound for steel, SAE AMS-1547 (formerly P-C-535), is used for alkaline electrocleaning. A hot water rinse (above 180°F) must follow the electrocleaning process. Decomposition of water with the evolution of the gases results when a low voltage current is passed through the electrocleaning solution to the item. Gas bubbles develop on the surface of the item and as they expand and escape to the surface, they exert both a "throwing off" and a "scrubbing" action, which is very effective. This process should be used only on unit items or simple assemblies. Items having internal cavities should not be electrocleaned, since only small amounts of gas are liberated on these internal surfaces. Items of magnesium, zinc, or their alloys should not be electrocleaned unless special approval is obtained and special cleaners and special care are employed in their cleaning. Highly finished or critical surfaced items should not be cleaned by this process. The steps in performing this process are -

- X Wear protective goggles, gloves and aprons.
- X Attach items to cleaning fixtures and lower into cleaning tank with solution of 8 to 12 ounces of compound per gallon at 205° to 212°F.
- X Clean items by making them cathodic (charged negatively) for 1 to 5 minutes.
- X Relieve hydrogen embrittlement by reversing the current and making items anodic (charged positively) for 15 to 30 seconds. (If the tank does not have a reversing switch, two separate tanks are necessary.)
- X Transfer items to the rinse tank. Allow time for excess cleaner to drain, without drying on the item.
- X Rinse items for 30 to 60 seconds in overflowing hot rinse water (above 180°F).
- X Inspect item for cleanliness by watching for an even flow of water from surfaces without any breaking of the water film.

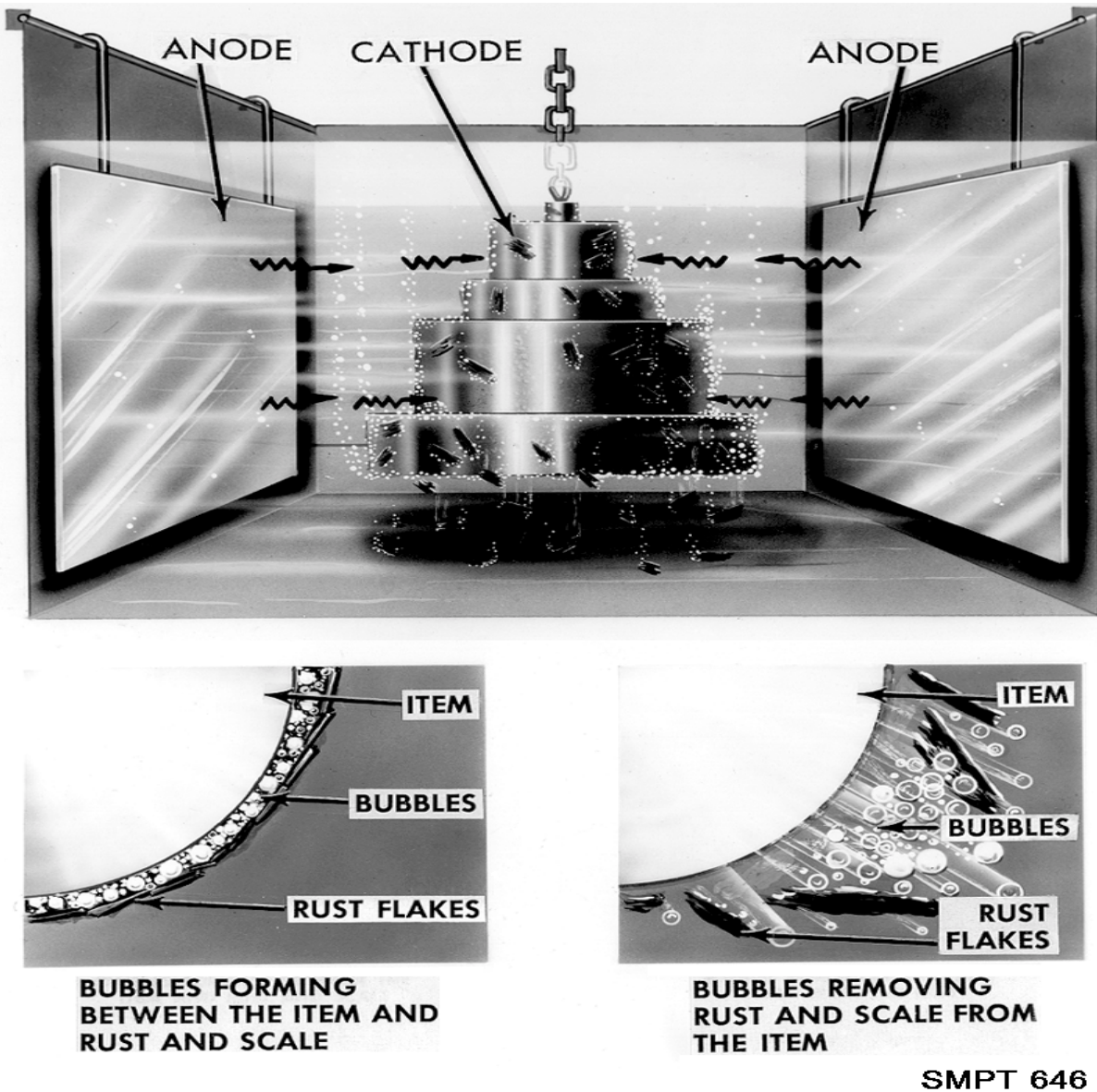


Figure 2-26. Electrocleaning.

**Emulsion Cleaning (figure 2-27)**

Emulsion cleaning is accomplished by blending an emulsifying concentrate with kerosene. The cleaning operation removes oil-soluble and water-soluble contaminants. Emulsion cleaning removes contaminants not readily removed by vapor degreasing alone or alkaline cleaning alone. It combines desirable features of both of these processes. Kerosene is mixed with the emulsifying agents and applied to items by immersion or spraying. Additions of small amounts of alkali to these emulsions are sometimes recommended where heavy oils and greases are to be removed.